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AUTHOR Cobern, William W.
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ABSTRACT

World view variations potentially interfere with science education, particularly when instruction proceeds unaware of the importance of fundamental epistemological structure of learning. The research reported here specifically addresses the cognitive culture of women college students with respect to conceptualizations of nature, a delimitation of world view. Equally important objectives were to develop further the logic of justification and to test the effectiveness of interpretive, ethnographic methods. The approach to cultural study taken in the current research involved the use of logico-structuralism, a world view model adapted from cultural anthropology. The subjects of the study were 20 college students enrolled in a science course. Data were collected via semistructured ethnographic interviews. The structure came from projection devices used to encourage the participants to talk about the natural world. Three elicitation devices were employed to elicit conversation beyond what the photograph and initial question could accomplish alone. The analysis of interview transcripts followed a grounded theory format. This process led to inferences about students' fundamental views toward the natural world. Several students did not connect knowledge of the natural world with science. Many of the students had a strong aesthetic sense about the natural world. They preferentially understood nature in terms of beauty and design. These students had a strong sense that nature must be conserved. Finally, these students generally viewed the natural world as orderly. If the science classroom is anything like that suggested by some research, then there is indeed a mismatch between many students' views of the natural world (e.g., aesthetic) and the view presented in science classrooms (e.g., materialistic). An explanation of elicitation devices, conceptualizations of nature codes, and concept maps and narratives of the respondents are appended. (40 references) (KR)

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The Natural World as Understood by Selected College Students:

A World View Methodological Exploration

Alternate title: Living Harmoniously with Nature: A Microethnographic Study of How Selected Women College Students Conceptualize Nature

A paper presented at the 1991 annual meeting of the National Association for Reserach in Science Teaching, Lake Geneva, WI.

William W. Cobern, Ph.D.
Assistant Professor of Science Education
Arizona State University West
Phoenix Arizona

602/543-6334
ICWWC@ASUACAD

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What do students *believe* about the world around them? Hawkins (1983) suggested that students can have a difficult time understanding heliocentrism because their personal experience is literally *geo*centric. The possibility of meaningful learning in the science classroom presupposes that students enter with personal contexts, their personal backgrounds, compatible with science as it is taught in the classroom. The study of student context (or for that matter, teacher context) at the most fundamental levels is the study of world view (Cobern, 1991a). The research reported here specifically addressed the cognitive culture of women college students with respect to conceptualizations of *nature*, a delimitation of world view. The investigation was an exploratory investigation in uncharted waters, and thus equally important objectives were to further develop the logic of justification and to test the effectiveness of the interpretive, ethnographic methods so justified.

Cultural Studies

Science education researchers have shown considerable interest in high visibility factors such as gender, race, and ethnicity. An anthropologist would consider these to be aspects or factors of culture, yet in science education research these factors are not addressed in a cultural sense. These and other attributes are used as nominally assessed variables in quantitative models:

$$F(x) = \text{science achievement or attitude,}$$

where x represents designations of race, gender, or ethnicity. The model implies a behavioralist approach to education that fundamentally says, if you have type x student in your classroom then use type z instructional activity. The object of research is to match x's and z's so that one achieves intended outcomes of instruction. Cultural studies in science education, however, seeks to employ an anthropological view of culture (Cobern, 1991a). An anthropological view of culture is far more holistic than the view from behavioralism:

> man is an animal suspended in webs of significance he himself has spun, I take culture to be those webs, and the analysis of it to be therefore not an experimental science in search of law but an interpretive one in search of meaning. It is explication I am after, construing social expressions on their surface enigmatical. (Geertz, 1973, p.5)

In a quantitative, behavioral model there is no Geertzian sense of culture as a web of meaning. In science education research where gender is a nominally assessed factor, there is no sense that one might be dealing with something uniquely feminine, for example. Any possibility of a feminine oriented web of meaning is collapsed into the nominal designation, *f*.

Interpretive* research asserts the importance of the context in which quantitative variables are embedded. As Geertz noted, the research objective is to explicate meaning from data that is enigmatic at the surface. Such an objective implies a very different view of instruction and instructional improvement. There is no sense that learning or attitude development is an effect that comes about by any one causal factor, or numerical combinations of casual factors. This is not to deny that research has found some procedures to work better with respect to producing intended outcomes than others (e.g., Clement, 1987). For very limited situations this has happened. However, there are pervasive problems in science education. Of this situation Hawkins wrote:

> reasonably patient explanation is no cure... we are up against something rather deep in the relation between science and common sense; we are up against a barrier to teaching in the didactic mode which has hardly been recognized, or if recognized has been seen mainly as a challenge to ingenuity in teaching rather than as a challenge to a deeper understanding of human learning... (1978, pp.5&7)

Interpretive researchers share Hawkins' view. Interpretive research does not expect that the procedures of experimental natural science can ever be used to produce general laws of education. Rather, one must come to a greater understanding of what meaning is and how it is created. Similarly, the classroom environment is not to be composed of causal factors, but an environment *shaped* to fit the members of the classroom -teacher and students (Lincoln & Guba, 1985).

World view is a concept that can be used to explicate meaning whether it is meaning for the teacher, students, or of the textbook. World view research focuses on cognitive culture as it exists in and is supported by socio-material culture. Some interest in cognitive culture has been shown. Toulmin (1972) wrote of the need to view thinking in terms of a "conceptual ecology." Strike & Posner (in press) suggested that "anomalies, analogies, metaphors, epistemological beliefs, metaphysical beliefs, knowledge from other areas of inquiry and knowledge of competing conceptions" are entities that comprise a conceptual ecology. Logico-structuralism is a theory from cultural anthropology which provides structure for the notion of conceptual ecology by postulating a set of universally found, fundamental world view categories (Cobern, 1991a). The category, NonSelf, was the focus of the present study.

Quite simply, the NonSelf refers to literally everything a person distinguishes from herself.

> The NonSelf can be divided into domains of... human environment and physical environment, or society and nature... Most cultures, including Western culture,

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*In the literature "interpretive" and "qualitative" are frequently interchanged adjectives for a particular type of research. I prefer the use of interpretive because I believe that it speaks more directly to what is distinctive about the research that goes by these two, and several other, names.

> have preferred Redfield's tripartite division: Humanity (society), Nature, and God (the transcendent)... the aspect of the NonSelf of interest in the science classroom is nature. From a world view perspective, one would ask: What is the image of nature projected in the science classroom? What is nature like according to science instruction? (Cobern, 1991a, p.45)

The purpose of the present study was to explicate the conceptualizations of nature, or the natural world, held by a particular group of students. In addition to the theoretical work of Cobern (1991a), Ogawa (1989) supports the assertion that conceptualization of nature is a significant issue in science education. Ogawa noted that one goal of Japanese elementary science education is to nurture a love of nature. The typical description of Western science does not include the love of nature; however love of nature is "closely related to the Japanese traditional (or indigenous) culture" (p.248). Ogawa noted that while elementary science is well received among students and parents, secondary science is not. In contrast to elementary science, Japanese secondary science is quite westernized. Ogawa concluded his article with the suggestion that similar cultural differences may well exist within the West.

As will be noted later, in interpretive work it is crucial that the researcher share a threshold level of understanding with the people with whom he is working. Effective social interaction requires a minimum level of shared understanding. Since the researcher and the respondents were all westerners, a significant amount of shared understanding can be assumed *a priori*. Nevertheless, variation within western culture advises one to acquire a broader understanding of the different ways in which westerners have historically viewed the natural world.

CONCEPTUALIZATIONS OF NATURE IN WESTERN CULTURE

Ogawa (1989) made the intriguing observation that while Westerners debate whether science education should be education *in* or *about* science, neither side questions the definition of *science* in science education. Neither do the debaters examine the presuppositions assumed under the concept science. In contrast, the principal interest in cultural studies is the explicit examination of tacit assumptions (Heller, 1990). Among science educators one such tacit assumption concerns the understanding of the ontological status of the natural world.

The modern, Western view of nature is characteristically *mechanistic* -which is easier to say than explain. Historically, mechanicism referred to a non-organismic view of the world as a "great machine, which, once it has been set in motion, by virtue of its construction performs the work for which it was called into existence" (Dijksterhuis, 1986, p.495). With its theistic implications this was Newton's view. The modern form of the concept retains the non-organismic machine metaphor but without the theistic or deistic implications. It is essentially a view that posits the whole as a simple sum of its parts. Causal relations are linearly conceived and context independent. Key elements in this view are the "regularity, permanence and predictability of the universe" (Kearney, 1971, p.24). With all due respect to quantum

mechanics, mechanicism remains a pervasive view in western culture, including the science classroom (Kilbourn, 1984; Proper, Wideen, & Ivany, 1988). This view of nature will subsequently be referred to as the standard or orthodox view.

Though it can be argued that mechanicism is the orthodox metaphor in western culture with respect to nature, there are other metaphors such as organismic and mystic. According to historical analyses of the Western view of nature provided by Glaacken (1967), Merchant (1989), and Thomas (1983), organismic and mystic views were dominant in earlier periods. In the Medieval and Renaissance periods mystical views based on ancient writings ascribed to Heremes Trismengistus, were prominent among alchemists. Mysticism was arguably influential in the thinking of Copernicus, Kepler and Newton. Organicism was, however, the dominant view from ancient Greece through the European middle ages. In this view one explained,

> the natural world in terms of analogies drawn from... biology... What struck this type of mind about nature was not its regularity and uniformity, but its constant change. Yet within the process of change there was a consistency which had to be accounted for... This led to the view that there was a potentiality or purpose built into all natural phenomena... (Kearney, 1971, p.23)

As the Medieval period waned, the competing paradigms of mysticism, organicism, and mechanicism, contributed significantly to the intellectual tumult of the era.

The emergence of mechanicism in Europe was facilitated by scholasticism. Scholasticism, the great task of Medieval theology, was the reconciliation of the Christian gospel and Aristotelian rationalism where a critical point of contention was the nature of the natural world. In classical Aristotelianism the world was necessary, eternal, and thoroughly organismic. It was qualitatively similar to animal and human life. In contrast, the Christian and Hebrew scriptures asserted that the world was a divine act of *creatio ex nihilo*; and thus was finite and contingent rather than eternal and necessary. This view was strongly supported by decrees in 1277 issued from the intellectual and theological centers at Paris and Oxford (Klaaren, 1977). Contingency and finitude provided the break with classical organicism necessary for mechanicism which subsequently gained ascendancy between 1500 and 1700. The distinctiveness of the modern, western view of nature can be seen in a cross-cultural comparison provided, tongue-in-cheek, by Watanabe (1974):

> Three men went to see Niagara Falls. One was an Indian from India, one was a Chinese, and one an American. On seeing the falls, the Indian, as a matter of course, thought of his god, manifested in this grandeur of nature. The Chinese simply wished to have a little hut beside the falls, where he might invite a friend or two, serve tea, and enjoy conversation. The American, however, on viewing the falls, immediately asked himself what could be done to make the most of such an enormous amount of energy. (p.279)

Some argue that western mechanicism has run amuck. White (1967) argued that a mechanistic

view of nature is at the root of western ecological crises (also see LaFreniere, 1985). Harding asked, "[Why] is it not as illuminating and honest to refer to Newton's laws as 'Newton's rape manual' as it is to call them 'Newton's mechanics?" (quoted in Levin, 1988, p.102). Merchant (1989), with considerably more balance, argued that the virtue of organicism was that it fostered the belief that people ought to live within the cycles of nature, whereas mechanicism fostered exploitation. Nevertheless, whether one prefers to call the collapse of organicism and mysticism the desacralization of nature, or Merchant's (1989) more judgmental "death of nature," this development in Western intellectual history was a crucial antecedent of the emergence of modern, experimental science (Foster, 1934; Oakley, 1961).

Cultural historians, while generally agreeing that mechanicism is the orthodoxy of the west, views of the natural world related to mysticism, organicism, and mechanicism all exist today. This discussion can be summarized as follows. Mechanicism permeates western thought but not all westerners view nature as an object to be studied for the sake of knowledge, control, and utilization. Some people view nature as art. This is often an empathetic view that nature offers one respite from the chaos of everyday life. Some people view nature as a symbol. It either stands for God and his benevolence, provides evidence of God, or provides natural symbols that support important aspects of culture. For some, the natural world is primarily an object. Critics argue that the objective view of nature is the pervasive view of science and science education (Whatley, 1989), and, in fact, antithetical to a feminine perspective (Merchant, 1989). For a similar summary of conceptualizations of nature, see Knopf (1987).

For the purpose of this report, the above discussion serves notice that within western culture there are different ways of conceptualizing nature, and that the received, mechanistic view, which is usually taken to be the western scientific view, is not without problems. Thus, for the science educator, questions come to mind. If one does not assume a mechanistically oriented conceptualization of nature, then how do students conceptualize nature? Secondly, what is the interaction of these conceptualizations with what typically happens in science instructional episodes? As noted, the purpose of this research is to address the first question with respect to a selected group of science students.

A METHODOLOGICAL SYNTHESIS: WORLD VIEW, HERMENEUTICS, And SEMIOTICS

The contrast between interpretive and quantitative research has been thoroughly examined. As early as 1979, Schwartz and Ogilvy wrote in Kuhnian terms of a new, interpretive paradigm that is virtually incommensurate with the existing and dominant, empiricist paradigm. In 1985, their argument was explicated and extended in Lincoln and Guba's seminal book, *Naturalistic Inquiry*. More recently, John Smith (1989) has contributed an important philosophical analysis of the two paradigms. In science education, Roberts contributed a highly relevant discussion of the paradigm issue in 1982. More recently numerous interpretive studies have been reported on at science education research conferences and in the science education research literature (e.g., Tobin, Kahle, & Fraser, 1990). The emphasis in interpretive work is clearly on contextualized

understanding rather than on decontextualized explanation.

The different paradigms raise a question concerning the nature of knowledge. The traditional view of knowledge posits a distinction between *episteme* and *doxa*, arguing that:

> when we know, interpretation is unnecessary; and when we interpret, we do not know. It follows that knowledge and interpretation are mutually exclusive categories. (Rockmore, 1990, p.116)

However, developments in philosophy demonstrate that interpretation and knowledge have in fact never been separable. Knowledge involves interpretation (Rockmore, 1990). The important question in interpretative research is not whether it produces knowledge - it does. Rather, the question of interpretive research is about the justification of knowledge. Researhers are addressing this question, but as late as 1990, Lythcott & Duschl wrote:

> we must continue, as a research community, to explore and reexamine... methodological issues. It is imperative because, on the one hand, the bases of our research arguments are often not made explicit in publication, and on the other hand because it is clear that what is required for sound arguments from qualitative data has been in some cases seriously misunderstood and applied by science education researchers. (p.445-6)

Lythcott & Duschl go on to explain how constructivist theory can be used as a "backing for interpretative research knowledge claims in science education" (1990, p.459). The discussion that follows pursues the concept of backing by first examining an oft overlooked distinction between quantitative and interpretive research, and then describing a philosophical sysnthesis intended to support interpretive research.

The principle action in quantitative research is the quantification or measurement of a variable such as concept attainment, formal reasoning, or attitude toward science. The primary vehicle for obtaining quantification is the "objective" instrument, objectivity resting on agreed standards of reliability and validity. The objective instrument is designed by a researcher and includes not only the items of the instrument, but the responses as well. Response meaning resides with the researcher. Without denying the usefulness of quantitative research, it is instructive to note a certain peculiarity. At no time can it be said that the responses in quantitative research belong to the subjects taking or completing the objective instruments. A subject merely chooses a response that belongs to the researcher. The researcher is measuring the subject, who, as the term "subject" implies, is passive. This should not be surprising since the concept of objective instrumentation is one borrowed from the natural sciences. When a chemist determines the mass of a lump of lead, the lead is a passive subject. Mass is passively registered on the chemist's instrument, and clearly the mass measure belongs to the chemist, not the lead. Furthermore, interaction between the lead and measuring device is not expected. Any interaction that does occur is seen as a source of error. Interaction is cause for concern that the measurements might not be objective.

Interpretive research, grounded in constructivist theory, stands in marked contrast. In interpretive research, meaning resides with the respondents or informants. The interpretive researcher's goal is to reconstruct or interpret that meaning much the same as a listener in a conversation interprets the speech of a speaker. The process of conversation or discourse is inherently interactive, and it makes no sense to think of measuring anything. Rather, in a conversation one seeks to learn about another by listening to him talk about himself. Of course, the listener has some preconceptions, but for a good listener these are heuristic, not prescriptive. The difficulty in interpretive research is that meaning is mediated through *text*, i.e., the transcript of an interview or the videotape of a teaching/learning episode. The methodological question of how to get *good* text is adequately discussed in sources such as Lincoln & Guba (1985). The uniqueness of text and what that uniqueness means for interpretation, however, is inadequately addressed. This is a weakness in the justification for interpretive procedures that can be redressed with a synthesis involving hermeneutics, structuralism, and semiotics.

Hermeneutics

Hermeneutics "refers to the intellectual discipline concerned with the nature and presuppositions of the interpretation of human expressions" (Harvey, 1987, p279). It is the study of the methodological principles of critical interpretation or exegesis (valid reconstruction). Hermeneutics provides the justification for interpretation, the principles necessary for objective and valid exegesis. The hermeneuticist assumes that something is hidden which should be brought to light. According to Hultsman & Harper (1991):

> hermeneutics belongs to the tradition of trying "to see" (i.e., to grasp, to apprehend) things the way they are. But what distinguishes it from other humans sciences is that the organizing metaphor is not vision - the preferred paradigm for most methods - but language.

Language is a medium of communication, yet the meaning in language is not self-evident. As clearly demonstrated when working between two languages, meaning in one is not conveyed to the other by simple translation. One cannot employ a Spanish-English dictionary to translate literally word by word from English to Spanish and thus ascertain the meaning of a paragraph. Meaning comes by interpretation. Even in the same language, language does not provide a direct link between one person's thought and another. Rather, language is composed of signs or symbols that have meaning. Language is a collection of signs that both individually and collectively carry numerous meanings. Often the intended meaning is quite different from the meaning of a literal translation as in satire and irony. Meaning always requires interpretation.

The terms *sign* and *symbol* are virtually synonymous. A sign symbolizes something other than itself. There is, however, merit in observing a distinction. A sign is a subtle symbol. *Old Glory* is a quite explicit symbol for the USA and attitudes that many Americans have about their country. *Chair* is a far more subtle symbol, more accurately a sign. At a surface level the sign *chair* signifies a constructed device upon which one sits. There are also derivatory meanings

such as department chair at a university. There is further symbolism that is so subtle that one is rarely conscious of it. *Chair* cannot be literally translated into all languages. Some cultures simply have no devices constructed for the specific purpose of sitting. For these cultures the closest meaningful, English sign related to chair is likely to be *seat*. The sign *seat* is derived from the action of sitting down rather than from the object upon which one sits. The presence of the sign *chair* signifies something about the material culture of native English speakers. Later I will refer to this type of symbolism as *deep structure*. Deep structure is indicative of the depth and richness of language, and is what leads one see that, in fact, reality is embodied in language. Reality is manifested in the signs of language. Thus, understanding someone else's reality requires the indirect approach of interpreting signs rather than a direct viewing of that person's reality.

If one understands that a teaching/learning episode involves realities constructed by students and teacher, then hermeneutics and semiotics provide a different set of metaphors for describing the events of a teaching/learning episode, and thus a different perspective. A teaching/learning episode is a social interaction. To be meaningful, any social interaction requires shared understanding, or shared meaning. At a minimum shared understanding in the classroom must include a shared understanding of the culture of school, the semiotics of the subject matter, and a shared personal understanding between students and teachers. Shared understanding in a social interaction allows for the development of new meaning. Without it, the teacher and students are literally in two different worlds. In turn, however, shared understanding is developed through social interaction. It is the biology teacher's intention, for example, that the students' shared understanding of biology will increase because of the social interactions that are the biology teaching episodes.

The semiotic triangle is a useful way of thinking about the construction of meaning. The semiotic triangle is:

> an irreducible triadic relation of (a) sign (something which stands to somebody for something in some respect or capacity - its grounds), (b) object (that for which the sign stands), (c) interpretant ('another sign, equivalent to or more developed than the original sign and caused by the original sign in the mind of the interpreter'). (Park, 1986, p.38)

Applied to the science classroom, sign is the representation of a scientific concept (the object), usually the interpretation of a science concept provided by the teacher or textbook. The students hold the interpretant, that is, student constructed meanings. The interpretant, however, is often quite different from what the science teacher or textbook intended. Though a number of possible reasons come to mind, the interpretation advanced in this paper is that quite possibly the original sign was of an alien culture. There was insufficient shared understanding for the student to interpret the episode in a fashion analygous with the teacher's intention. As Hawkins (1983) has said, painstaking explanation avails very little.

The function of hermeneutics is to bring teacher and student to an appreciation of their

different ways of thought. The doing of this can be described in the Kuhnian terms, *normal* and *creative* hermeneutics (Gutting, 1984). Normal hermeneutics refers to the task of interpreting existing views of reality, whether it is that of a student, teacher, or textbook. (The research being reported is an exercise in normal hermeneutics.) Normal hermeneutics precedes creative hermeneutics which is:

> the source of alternative conceptualizations... not just a grasp of already available alternative conceptualizations. Such creative hermeneutics doesn't work *ex nihilo*... it takes materials form our entrenched conceptualizations and shapes them into an essentially new viewpoint. (Gutting, 1984, p.14-15)

A teacher practices creative hermeneutics when she draws from her own understanding of a concept, and in the light of a student's viewpoint she reconceptualizes the concept. The reconceptualization is literally new for both student and teacher. Now, however, the signification of the concept embodies a shared understanding of reality as known by teacher and student that allows for an acceptable interpretant.

Discourse as Text

The discussion thus far has focused on language within social interaction. However, hermeneutic principles act on *text*. Text is the content of written or spoken, verbal communication. In hermeneutics, a critical distinction is made between "discourse as text" and "discourse as conversation." Conversation is temporally located in a social interaction. It exists here and now. In conversation a speaker expresses his own thoughts in a dialogue with another person. This "suggests that in conversation meaning exists between two speakers, meaning is located in the event of the discourse itself" (Honey, 1987, p.76). Discourse as text is *fixed* discourse. It allows the advantage of communication across distances of space and time. However, given that meaning in conversation exists in the event of conversation, the meaning of text cannot be isomorphic with the meaning of conversation. According to Honey:

> in the act of being written down, meaning undergoes a kind of self-alienation. Not only does the text no longer reside within the context in which it was produced, but the meaning embodied in the text is no longer the property of a particular author. (1987, p.75)

Gadamer used similar terminology, "alienated speech" (1975, p.354). The hermeneutic expression is *distanciation* of meaning. The act of writing down the discourse of conversation results in a set of signs, the discourse of text, that represents the meaning that was extant in the social interaction. The discourse of text requires interpretation. The meaning of the signs must be reconstructed. This is the task of hermeneutics.

The relevance of text and hermeneutics to interpretive research in science education is this. The activities of interpretive research create text. Classroom discourse is *fixed* by

videotape. Interview discourse is *fixed* by audiotape and transcription. The fixation distances the text from its origins. Meaning no longer exists in the event of conversation (e.g., the interview event) because the event no longer exists. Meaning now exists as signs in the text. The interpretive researcher now becomes a hermeneuticist who attempts to reconstruct meaning.

The Conceptual Issues of Hermeneutics

There are three conceptual issues that frame the operations of hermeneutics in the task of reconstructing meaning. The first conceptual issue concerns the form of the text. As noted above, text is fixed discourse. The discourse, however, can be of various forms. Because form has a bearing on how the text is to be interpreted, the first issue is the nature of the text under consideration. Originally the text of hermeneutics was the Bible and other ancient manuscripts. This concept of text was easily transferred to literary texts, such as the novel or poetry. In more recent years the concept has been extended to include artifacts of material culture such as the architecture of Medieval cathedrals (Hallyn, 1990). In education, one can extend the concept to include artifacts of education such as student work, textbooks, or lecture notes.

The concept of text is more than one of language. According to Ricoeur, text can be virtually any type of "meaningfully oriented behavior" (1981, p.203). As already noted, the concept of text applies equally to the transcripts of verbal interviews (Honey, 1987) or the videotapes of classroom activities, for example, as it does to a textbook. Yet, there is an important distinction to be made. It concerns *authorial intent*. If the research question is about student culture and the text is a student essay, then interpretation must attempt to over come distanciation. If the research question is about how science *is* signified, rather than how it came to be signified, in a textbook or in a lecture, authorial intent is virtually irrelevant. The rational for this distinction is rooted in the differential aspects of understanding text.

The second conceptual issue that frames the operations of hermeneutics, and arguably the most difficult issue, concerns what it means to understand the text. At the broadest level of generality, the hermeneuticist grounds understanding on the hermeneutic circle. Park explains with an analogy from foreign languages:

> Anyone who has struggled to understand a document written in another language will recall that a word (or words) takes on meaning in relation to sentences and paragraphs, and sentences and paragraphs in turn help to clarify the meaning of words. (1986, p.40)

The whole of a text is understood as it stands in relation to its parts, which in turn are understood as they stand in relation to the whole of the text. Neither part nor whole can be properly understood in isolation. The whole and the part form the interpretive whole. Yet, any given example of a hermeneutic circle exists in cultural context. There is always a second hermeneutic circle. A text is one part in a cultural whole.

At the narrowest level of specificity (and only when appropriate), the hermeneuticist grounds understanding in *authorial intent.* Understanding authorial intent begins with understanding the grammar and semantics of the author's language, as well as other modes of expression such as gestures and tonal inflections. One *explains* a rock by describing its features. One *understands* a person by discerning essence and self-understanding. For example, hermeneutics can be used to help understand how student culture, i.e., student reality, influences the interpretant of the semiotic triangle, and for this authorial intent is crucial.

The paradox, of course, is that text is alienated speech. One can never expect that reconstructed meaning will be isomorphic with the meaning that existed in the original event of discourse. But this is far from fatal. That culture influences expression is a crucial hermeneutical assumption. Reality is embodied in language. The signs that an individual uses in communication are derived from a shared cultural understanding. While the exegesis of text cannot isomorphically reconstruct original meaning, it can reconstruct cultural meaning. The hermeneuticist, thus, argues that by placing the author in cultural context it is actually possible to understand the author better than he understands himself.

The understanding does not begin at the point of complete alienation. The hermeneuticist at the start must share some understanding of the author's culture or there can be no communication whatsoever. *Prolonged engagement*, which is discussed below in the section on the trustworthiness of interpretive research, is the researcher's method of gaining the necessary cultural awareness, the threshold level of shared understanding. The point is that alienated speech notwithstanding, the researcher can gain valuable cultural knowledge through the interpretation of text.

The hermeneutical goals are to understand both the author and his culture through the interpretation of text. When the text form is a book or lecture, the research frame changes. For deconstructionists, radical hermeneuticists, and for radical constructivists, language is everything. Rather than language being a representation of external reality, language creates reality. Even for moderates, a textbook once written creates a reality of its own regardless of, though not unrelated to, authorial intent. A textbook is one of the possible *signs* in the semiotic triangle of sign, object and subject/interpretant. The reality signified by the textbook is what is important in the semiotic triangle, not the textbook author's original intent. Thus, the hermeneuticist seeks to understand the culture embodied in the textbook. In this case, hermeneutics is used to help understand how a textbook, regardless of authorial intent, influences the result of the semiotic triangle where students are the subjects.

While authorial intent is far more important in the interpretation of some types of text, for example the transcript of a verbal interview, the goal of cultural understanding remains constant for all types of text. This raises the obvious question of how one interprets culture though text. One response comes from cultural anthropology, *structuralism.* Text can be structurally construed, a notion that originated with Levi-Strauss'(1963) application of de Saussure's structural linguistics to the study of culture. Levy-Strauss was not so much interested in the literal interpretation, or surface structures, of cultural events and artifacts as he was in deep

structures. He sought to identify underlying structures of thought that characterized a society or group. The logico-structural theory of world view employed in the present research is a form of structuralism (Cobern, 1991a). The categories of logico-structuralism are deep structures reflected in language and culture.

Structural Analysis is the method of examining the typically subconscious infrastructure of cultural phenomena, the presuppositions within logico-structural categories. Structuralism considers the elements of infrastructure, or logic-structural categories, to be "relational." Analysis, therefore, treats categories as related entities, rather than independent entities. Infrastructure is viewed as system and must be analyzed as such. The *logico* in logico-structuralism is a reference to system in that the categories of world view stand in systemic relation to each other. Logico-structuralism in effect structures conceptual ecology, to borrow a phrase from Toulmin (1972), by postulating a set of universally found, fundamental world view categories: Self, NonSelf, Classification, Relationship, Causality, Time and Space. The power of logico-structuralism lies in its composite structure of the seven inter-related, universal categories. In principle, groups of people and even individuals can be identified by world view variations which result from the content variation of categories. This composite nature of the logico-structural model focuses the researcher's attention on the complexity of world view, and yet the categories themselves provide access to that complexity. The theory of logico-structuralism and its application in research is discussed in Cobern (1991a&b).

The focus of the present study is the NonSelf. The study was further delimited by considering only that aspect of the NonSelf which is of principle interest in the natural sciences, i.e., the natural world or nature. In addition to the theoretical work of Cobern (1991a), Ogawa (1989) supports the assertion that conceptualization of nature is a significant issue in science education. Ogawa noted that one goal of Japanese elementary science education is to nurture a love of nature. The typical description of Western science does not include the love of nature; however, love of nature is "closely related to the Japanese traditional (or indigenous) culture" (p.248). Ogawa noted that while elementary science is well received among students and parents, secondary science is not. In contrast to elementary science, Japanese secondary science is quite westernized. Ogawa concluded his article with the suggestion that similar cultural differences may well exist within the West. For a discussion of possible disjunctions in western science classrooms see Cobern (1991b).

Semiotics is a more recent and more encompassing concept that grew out of structuralism. Semiotics is the study of all types of sign systems, codes, and conventions. In semiotics one says that "there is more here than meets the eye." When one wishes to communicate a thought, what one transmits are sounds and visual cues that represent, or are signs for, the thought to be communicated - not the literal thought. Culture is embodied in those signs as already noted. Semiotics seeks to understand culture as a system (structuralism) of signs used in communication and to understand who culture is tacitly communicated in signs. From the perspective of semiotics, a text such as student written work, or the transcript of a verbal interview, is the culturally influenced representation of the respondent's beliefs and ideas. Even if one cannot be sure of authorial intent, semiotics and structuralism imply that one can yet learn a great deal

about the respondent's culture. A textbook or a lecture, on the other hand, is a public document that exists independent of its author. From the perspective of semiotics and structuralism, it too is a culturally influenced representation. As text in the public arena, the representation is sometimes more, sometimes less, isomorphic with its author's original intent.

Audience is the third conceptual issue that frames the operations of hermeneutics. In this issue one asks "To whom is the text being interpreted?" because, interpretation and understanding are influenced by the presuppositions of the audience. In the current research, text is being interpreted for other science education researchers. To be an effective hermeneuticist I must bear in mind what these researchers typically believe about research questions, methods, and outcomes. If the text of the research were a science textbook, I would include a second, quite different, audience. In working with a textbook I would want to consider the culture of students for whom the book was intended. In referring again to the semiotic triangle, an observer cannot make sense of the interpretant without a threshold level of knowledge shared with the audience.

Summary

Hermeneutics "understands only what is said, but whether it is true or not, it does not know" (Birus, 1987, p.78). Truth is the subject of epistemology. The epistemologist asks, how do you know that? The hermeneuticist asks, why do you talk that way? What are you trying to say? The hermeneuticist argues that meaning is not self-evident but requires interpretation. Interpretive research typically involves the analysis of textbooks or lectures, transcripts of interviews or classroom videotapes, which is the analysis of *text*. Such analyses call for hermeneutics because the meaning of text must be reconstructed from signs that compose the text. The operations of analysis are framed by issues of text form, text understanding, and audience of text. The general rule of analysis is the hermeneutic circle. The next section discusses the specific application of these ideas in the present study.

PROCEDURES OF THE STUDY

The objective of this research was the mapping of belief space or terrain of belief regarding nature, i.e., to map the qualitatively different conceptualizations of nature held by the students. Such conceptualizations are called outcome space by Marton (1988) and belief space by Jones (1972). The findings are descriptive categories and brief narratives derived from modified naturalistic inquiry (Lincoln & Guba, 1985), interview technique (Kvale, 1983; Spradley, 1979), and constant comparative analysis and grounded theory development (Strauss, 1987). The intention was to develop working hypotheses, in the form of interpretive statements, through an emergent design as advocated by Cronbach (1975), Lincoln & Guba (1985), and Strauss (1987).

Text Development

The source of the data was an interview series conducted in the summer of 1990. Each

interview was audiotaped and each followed the same format. An interview began with a respondent being asked to view a set of naturalistic landscape photographs, and then asked a grand tour question, how would you define nature or the natural world? The interviewer's actions and responses were consistent with Spradley (1979) and Kvale (1983). Three elicitation devices were employed to elicit conversation beyond what the grand tour question and photographs could accomplish alone (See Appendix A). The first device was a word sort which essentially meant that the respondent rank ordered adjectives that could be used to describe nature. The adjectives, printed on cards, were shown to the respondent in three groups. The respondent separated each group into words that he would use with nature and words that he would not use. The useful words from the original three groups were then combined into one group and similarly the less useful words from the original three groups. In two separate tasks the respondent was then asked to rank order the words in the new groups, only this time the respondent was asked to think aloud about his decision process. The interviewer probed when appropriate for clarifications of the respondent's comments. The second elicitation device was an analogous task using complete statements about the natural world. The third device had the respondent compare random combinations of two sentences, choosing one to retain and one to be replace by a third randomly drawn statement until twelve comparisons had been made. As with the first device, the second two incorporated the think aloud procedure.

The elicitation devices were structurally informed in that they were based on the view that conceptualizations of nature are rooted in the world view category NonSelf, and that in western culture there are a limited number of ways in which nature is conceptualized. The structure in the devices partially overlapped allowing the respondents to be persistently engaged by concepts relevant to the study, thus minimizing the potential for unrecognizable insincere comments. Overlap also allows for triangular analysis of codes which improves the trustworthiness of interpretation. As will be noted later, device structure was manifested in etic codes and categories used in the preliminary stages of text analysis. Consistent with the concept of emergent design, the development of text was considered to have reached a level of sufficiency, or an appropriate endpoint, at the point of *redundancy* (Lincoln & Guba, 1985, pp.201-202). Redundancy reflects the nonstatistical nature or interpretive research. In quantitative research sample size is a critical issue because values of N are mathematically involved in all statistical procedures. Each subject in a sample provides an equal quantity of information. To increase the quantity of information and thus to increase statistical power, one increases sample size. In interpretive research one quickly discovers that informants are not quantitatively equal. Some informants are informationally more fruitful than others. Interpretive research requires informants who are both willing and capable of honest self-expression. Thus, the best indication of when one has enough information is the point at which additional information is largely redundant. Specifically, this can be taken as the point at which no further emic codes emerge from the data. Thus, the text for the study was comprised of ten individual transcripts, refered to as the text components.

Respondents

The interpretive researcher seeks to work with a distinctive group. Distinctiveness of group identity allows replication on the one hand. On the other, it allows one to show clearly that the same study is being done with a distinctly different group. Specifically, the respondents in this study were 15 caucasion women students (including one Hispanic women), between the ages of 21 and 45, who were preparing for a career in a science-based, helping profession - nursing. At the time of the interviews, the women were enrolled in a college level anatomy and physiology course at a metropolitan community college. All successfully completed the course. The intention was to interview as many students as logistically possible, and thus to assure that redundancy would be reached and exceeded. In fact, during the analysis of text, redundancy was reached with the tenth respondent.

To what extent is this a distinct group? Gender is clearly of interest in education research yet there remains the question of to what extent gender defines culture. In some societies it could be argued that gender in fact does not at all demarcate a subcultural group. However, the feminist scholarship in the West makes a strong case for the existence of a feminine culture vis-a-vis the traditional western culture of science (e.g., Whatley, 1989). Furthermore, there are science-related helping professions dominated by women. Women in these professions are neither scientists nor were they science majors, yet in preparation for these professions women must successfully complete college level science courses. Other than commonsense, there are no rules for determining whether this or any other group is distinctive. It is obvious that the group of all men subsumes an enormous amount of variation. The group of all men seven feet tall or more is certainly distinct, but also of no particular interest in science education. In this study there are three characteristics that combine distinct identity and science education relevance: gender (female), professional goal (nursing), and current situation (successful participation in a college science course).

Method of Text Analysis

The text was analyzed using the constant comparative method (Strauss, 1987). In brief, this is an iterative approach that begins with the coding of a text (code mapping), where code refers to a unit of information or chunk of meaning, intersubjectively controlled. In hermeneutic fashion, the use of a code in any one place in a text is constantly compared with code usage throughout the text. As the second, third, and fourth (etc) text components are mapped, code usage in any one place in any one text component is compared with code usage throughout the collection of coded components. The research began with a set of etic codes derived from earlier research (Cobern et al, 1990), and the above discussion of conceptualizations of nature in western culture. As warranted by text, emic codes were added and the definitions of both etic and emic codes were modified. Categories represent rule-governed collections of codes, that is rules of inclusion for codes. In this study, categories were construed as subconcepts to the concept of nature. Category mapping followed the same hermeneutical heuristic as code mapping. The mechanical processes involved in code mapping and the sorting of codes was done by computer (Seidel et al, 1988). The code/category lexicon is given in Appendix B.

Once the text was coded, segments of the text components were isolated and compiled into code groups. This facilitated the iterative, intra- and intertext comparison of coding required for the emic development of code and category mapping. Subsequently, each code in a text component was subjected to the following basic analysis and the information summarized on worksheets.

> How frequently does the code appear in the text component?

This information along with the elicitation device rankings and semantic clues within the text component were used to guide the saliency assessment of the represented information within the conceptualization represented by the text component.

> What other codes in the text component co-occur with this code in any given text segment?
>
> Is this code embedded in other codes or does it stand alone?
>
> Does this code subsume other codes?

For example, if in a segment Special and Aesthetic appear together one might find that in light of the whole text component, the emphasis in this segment is actually Aesthetic. Or, one might determine that the two codes are related in the sense that nature is seen as Special and that one aspect of this specialness is Aesthetic. In this case, a hierarchial arrangement might be proposed in an interpretation. Such an interpretation would be supported if there was a segment in which the code Aesthetic was found to be embedded in the code Special. Co-occurring codes deemed related may also lead to categories. For example, Resource and Preservation appearing together suggest the category Managerial. Or, Change and Order appearing together suggest the category Dynamic.

It makes no difference where the interpreter begins the above process, but there is reason to begin with a code that has a high frequency of co-occurrence because of the links for follow up that co-occurrence provides. For example, if the interpreter begins with Aesthetic which co-occurs with Special, the next step would be to examine Special. The interpreter would then examine all the codes that co-occur with either Aesthetic and Special, subsume these two codes, or codes subsumed by Aesthetic and Special. From this examination the interpreter would draw a preliminary sketch of how the various codes are related. Once all the codes in a text component are examined, the preliminary sketches are brought together to form a unitary concept map representing an interpretation of the conceptualization of nature represented by the text component. Following the principle of the hermeneutic circle, this is not a process of adding together parts to achieve a whole, but an iterative process of working back and forth between preliminary sketches and possible wholes until one achieves a concept map that best represents the entire text component. In addition, a narrative description using as much of the original text language as possible is written for each text component. The narratives are used in the process of member checking discussed below.

In this research the final step of analysis was the comparison and contrast of text component concept maps leading to a composite concept map representing the belief space presented by the students. As advocated by Jones (1972) paired orthogonal vectors were identified in the composite concept map as a way of further illucidating the students' views of nature. A vector pair represents two different perspectives that are either opposite or demark a range of views (e.g., naturalistic/religious). Thus, the actually findings of the research are the composite concept map and the set of descriptive paired vectors. Together, these map the students' belief space with regard to nature.

Trustworthiness

Throughout the study care was taken to assure trustworthiness as advocated by Lincoln & Guba (1985). On this matter, Smith wrote:

> *objective* is a term that simply refers to the fact that there has been an agreement among inquirers. Likewise, to be subjective is not to represent things as influenced by one's personal taste, personal opinion, or emotional reaction, but... it is to introduce considerations others find strange or beside the point. (1989, p.9)

The issue is credibility. The researcher establishes initial credibility by his preparation. Credibility requires that one prepare for the study by learning about the culture in which the study is to take place. In this study, preparation primarily involved examining existing studies on the concept of nature in western civilization to insure a threshold of shared understanding with the respondents.

The specific processes of text development also serve to maintain credibility. Text for a respondent is credibly developed through persistent observation. This requires that sufficient time be allotted for an individual respondent to speak freely and completely. In each interview of this study respondents were allowed to say as much as each wished. In addition, credibility was enhanced by using methodological triangulation. As reported above, three overlapping elicitation devices were used. As the mapping of each text was completed, the code maps of the text sections corresponding to the elicitation devices were compared. In each text case it was found that the codes did overlap when appropriate.

Furthermore, the objectivity of exegesis was intersubjectively determined by peer debriefing. Peers audited the logic trail for any *non sequiturs*. Finally, since authorial intent was an issue in this research member checking was conducted. Each respondent was asked to evaluate the narrative summary from her interview text. In each case the respondent strongly agreed with the narrative summary.

Discussion

Appendix C contains the complete set of individual concept maps and narratives from the study. Figure 1 is the composite conceptual map derived from the 15 individual conceptualizations of nature. This conceptual map is a visual of the belief space presented by this group of college women. It gives one an indication of the rich expanse of ideas that students bring to the classroom. Further analysis resulted in six orthogonal vector sets which can be used to lend further description to the students' belief space. These are discussed below with sample quotes from appropriate narratives.

1) Naturalism and Religion - Naturalism is a view of nature involving only natural causes and forces. It rules out theistic or pantheistic supernatural involvement in nature, but does allow deistic views. There is little middle ground between this vector and a religious vector representing direct supernatural involvement in nature. People tend to be one or the other. Carla is a good example of the naturalistic view espoused by six of fifteen informants, although Carla was the only one who specifically referred to herself as an atheist.

> Carla: I think of nature as everything that pertains to the planet. It arises from the planet. That involves the air we breathe, the oceans, the earth itself, the land, the living organisms that inhabit it... animals... flora... fauna... minerals... weather phenomena... I think it's everything. A religious person would say nature is there for a purpose. God put it there for a purpose. I don't think so. I'm an atheist.

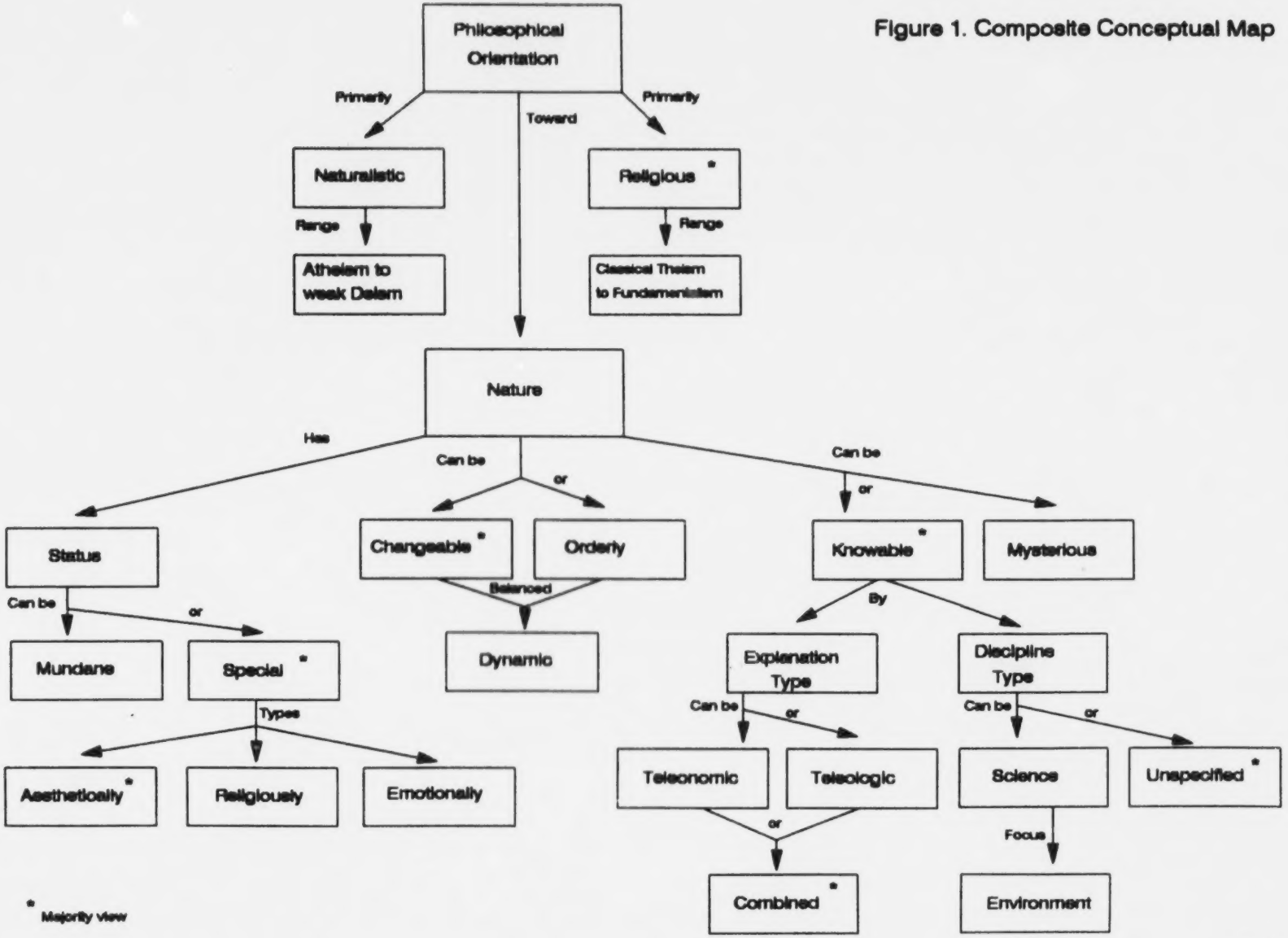
Flo and Kelly are good representatives of the nine informants expressing religious views. The example of Flo is particularly noteworthy because it shows that religious and scientific views are not necessarily incompatible.

> Flo: I believe in God and I believe that He created nature, but nature is not religious. If you see a sunset, you see God... but I know there is a reason for the sunset... I see, for example, biological reasons for things, not the work of God.

> Kelly: I believe in the creation theory... I think that God created everything... when I think of things he has created I think of beauty and goodness... there's a lot of beauty and goodness in nature.

2) Function and Purpose - The focus of this research was ontological conceptualizations of nature. However, as world view theory indicates it is difficult to cleanly separate categories. A good example in this study was the issue of function and purpose. These refer to explanations of how things happen in nature. Function refers specifically to teleonomic explanations while purpose has to do with teleology. The middle ground involves a complementary association of the two views of causality. Clearly this vector pair is closely related to the naturalism/religion vector pair. For example, none of the informants who had a naturalistic view of nature took a purely teleological position on causality, whereas two religious informants did. It is interesting to note that three of the religious informants took middle ground positions. In other words, being

Figure 1. Composite Conceptual Map



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religious does not rule out teleonomic thinking. Linda, who views nature naturalistically, expresses the functional view of causality.

> Linda: We know a lot about nature but we haven't really even scratched the edge. There's stuff out there that we don't even know that's there... as to how things work and stuff... I know people in the science area, there's a lot of stuff they don't know and I know even less; but it's important to understand how things work in nature because we'd more or less be dead if it wasn't for people researching... and, to bring up the rain forest again... they should realize that that's there for a reason and they're screwing up the rest of the earth by removing it... things work together like that... that's why we need to understand... Those trees are there for a reason and we need to understand what their function is.

Flo is one who believes that God created nature. She expresses the complementary view of function and purpose in nature.

> Flo: You don't know the reasons why some things happen, like natural disasters. You can question all you want. You can find out through biology and all the rest of the sciences but it's still a mystery to the people in those areas. There is a way to find an answer to the majority of your questions... like a stomach illness isn't mysterious because all the questions are answered, but if you have a question like why it rains on a particular day... well, its just your own religious belief.

Like Flo, Kelly is also religious. In contrast to Flo she has a very teleological view of nature.

> Kelly: As you go through the Bible... Christ had to do everything that he did... he had to do this thing and he had to do this next one and it was like all in order... it needed to be done and it was done... Likewise, everything has to be done in nature,... the big animals have to eat the little animals... little animals have to eat... the little bugs and they have to do that to survive so it... it has to be done.

3) Mystery and Knowledge- The third vector pair has to do with whether nature is essentially knowable or mysterious. People who find nature knowable believe that one can have teleonomic understanding of events in nature though that knowledge might be limited. Those who find nature mysterious are more impressed with what is not known than what is. The middle ground for this vector pair is the expression that significant knowledge is possible, but limited. Three informants expressed the mystery position. These three also were religious. Kelly is a good example.

> Kelly: Nature is mysterious... I think most spiritual things are kind of mysterious... I mean... just being overcome with a feeling of... like a godliness or something like that and then I think that everything... that you relate to as something holy is something

mysterious... like everything in the Bible is kind of mysterious. Things just... sometimes they just happen. I mean... everything can be fine and great one moment and then a tornado can hit and just everything can be destroyed and it can be just fine one moment and then the clouds... all come and bring the storms... things happen but you don't know why... I mean... like the seasons all come at a certain time and it seems like bears hibernate in the winter and it's just these things that happen... they're so, like weird sometimes. I mean, you don't understand why... you look at the stars and you think... how can those stars be just out there hanging? Or you think that there is some life out there... well, if it's possible here then why can't it be possible some place else and that's like mysterious. I mean, you know things about [nature] but... I just can't comprehend... like why does this happen or, you know, why does that happen? I know... how it happens... but why does it happen? You know, I just can't grasp some things.

In contrast to Kelly, Helen is a religious person who finds nature knowable. The difference between Kelly and Helen is that Helen holds a complementary view of function and purpose in nature.

Helen: Nature is the real physical world... we can test it and see what cells are in it or we can physically deal with it and learn about it so that's real to me... it's not an abstract thing necessarily. We have to dig down to get to it... through chemistry or biology or, you know, scientific methods... scientific study. We're finding out more things all the time. I mean, there are a few things we don't know but we have an inkling of why they are that way and we're getting closer and I don't think nature is such a mystery anymore as what it used to be. Through research we're finding out so much and I don't think there's too much that's going to be left unknown eventually.

Earlier, Carla was given as an example of one having a naturalistic view of nature. As a teleonomic thinker she also views nature as knowable.

Carla: You can study nature and learn about it. I've had a lot of science classes I understand and chemistry. I understand the chemical principles of a lot of things. I understand how bacteria work in the ecosystem now that I've studied it. It's coming together for me. I understand what I've learned so far. I'm interested in anatomy, physiology... interested in how the body works... It's like a machine... I'm interested in nature. I enjoy microbiology, understanding how things work, not just on an molecular level, but, you know, on a higher level, too. I like to know how things work out there.

4) Change and Order- There are three possible positions. Nature can be seen as basically changeable, orderly, or a dynamic system involving both change and order. Denise is a good example of one who sees rather chaotic change in nature.

Denise: Manmade things are orderly... but not nature. Nothing is really solid, nothing is really for sure, you know... an earthquake or something... you're not sure tomorrow's going to come. Things don't always happens the way we think they're going

to happen, so it is not orderly the way manmade things are.

Elizabeth also sees change in nature but it is a less chaotic type of change.

> Elizabeth: I think nature is always changing. Nature adapts... As nature is settled by man the animals and nature still survive somehow... they change their habitat and find ways to coexist with us. Change can be good, but it depends on which way its changing. You might have a drought... but I don't think that's not as big a problem as man himself.

In contrast there is Helen and Carla who find nature quite predictable. On this vector pair, Carla, the naturalist, and Helen, the theist, are together. The reasons are quite different, however.

> Helen: Nature is pretty predictable. It's orderly and you know what you can expect. If you do such and such, you can expect such and such to happen... it is because it all kind of works together. We have to have certain chemicals in our body... or, there may be salt in the earth because we need it for our body. I believe everything's orderly but it's for a reason... our survival... but it was through a divine thing that everything happened to be that orderly. I don't think it was happenchance.
>
> Carla: I'm a science major and... it's everything I've been taught that everything has an order to it... a system to it.

The middle ground position that nature is a dynamic system of both order and change is exemplified by Amy.

> Amy: Let mother nature do her thing. If we two-legged creatures can keep our nose out of her way, nature is very orderly. There's a reason for it all. I feel there is an orderliness in nature being left untampered... Where there is a flood or forest fire or something it's normal. It's just nature's way of taking care of itself. I don't think there's anything chaotic in nature. Individual phenomena might be viewed as chaotic by we humans but I don't think in the field of nature that there is anything chaotic involved. But nature is constantly changing. It's not necessarily going to be the same tomorrow or next week or next year as it is right now.

5) Mundane and Special- Is nature a work of art or a lump of clay? In this vector pair, special refers to aesthetic, emotional, and religious speciallness of nature. The opposite is the mundane and prosaic essence of nature. Of the fifteen informants, only one expressed a mundane view of nature.

> Irene: You deal with nature every day even though you don't think about it. It's like a grasshopper I killed in the bathroom. You know, that's just everyday nature. In nature there really isn't an answer to why questions. Sometimes things just happen because they

happen and you can't rationalize why they happen and no matter how much information you get... some things just happen. Sometimes there is no rhyme or reason...

For several informants, nature was special for aesthetic reasons.

Amy: I don't think nature is ordinary. Nature might be orderly and routine but it's not ordinary, but extraordinary. You know, good or bad, even a tornado, is beautiful from afar, nature can be beautiful when... it's not so much fun.

For others, nature is special for the emotional support it provides

Irene: When I think of nature I think of outdoors... just sitting by a stream and watching the water flowing over rocks. I think of nature as being alive, vivacious. I think when you get out, you can get away from a lot of stress... you can just relax and enjoy what's around us.

For some nature is special for religious reasons.

Georgia: I don't feel that nature is always beautiful or pleasant... it's not always delightful... but it's a place that you can always feel spiritual... close to God and close to your own feelings. It's a special place that God made. It's relaxing and helps you put things in perspective.

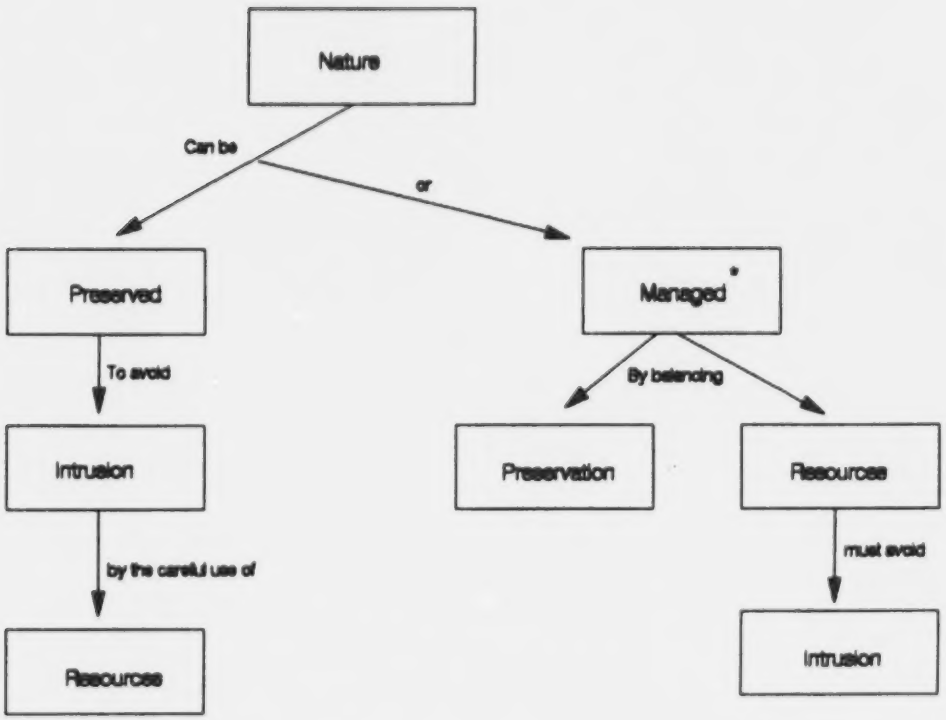
Sometimes the sense of religion and mystery are mixed.

Jackie: There are a lot of unknown things about nature. I wonder about all of them. I wonder about the little insects in the forest and things like that so it's a mystery to me how it's things all fit together and works together... I get this feeling it's like a special place... it's kind of holy... nature just gives me a very special feeling, I mean, when I'm like out in the woods... the beauty and the mysteriousness of it all and it's sort of religious to me. I mean, it's like a special place. I'm not a set person in one religion but nature does make me feel that there is a God when I see how things are created and what is happening.

6) Resources and Preservation (see Figure 2)- As noted above, world view categories cannot be cleanly separated and here is another example. In discussing nature, informants frequently spoke about relations with nature. The resource/preservation vector pair has to do with nature as a resource in contrast to nature in need of preservation. Management is the middle ground. This is the position that nature is a resource, but one that must be used carefully and protected. It is noteworthy that none of the informants expressed a resource oriented viewpoint. Eight expressed management views such as Amy's.

Amy: If we don't preserve our environment, we won't be able to meet any of the needs

Figure 2. Nature as Environment



*Majority view

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of the people. It's one of those things. Which came first? The chicken or the eggs. But I think we need our resources available and in order to do that we have to protect the environment... we must preserve our environment. But, we have to know how and the only way to do that is to study... We study nature so that we can live more harmoniously with nature. If we don't study and learn more about nature, know all we can, maybe not understand but know all we can, and be concerned about pollution, we won't have the trees to build our houses and the forests for our wildlife and everything will come to a screeching halt. We'll be back to caves.

Those expressing a preservationist view point clearly stressed preservation over utilization of nature. Irene is a good example of these seven informants.

Irene: We study nature so that we can live a little bit more harmoniously with it. Rather than trying to destroy it all the time... work with it. I think we sometimes wait 'til there's a problem... we do things and then we study about them... like with animals. We'll bring animals into a certain area to... like with the burros up in the canyons and how much damage they've done to the animals that were there and the environment as it was... there was a balance there... and now the balance is taken away. For the most part I think most people want to do their best to help with the natural environment and take care of it... I mean, that's everybody's ultimate goal, but we can only do the best we can and if each of us just does a little something it helps with the whole basic picture. But, we destroy natural areas due to pollution and toxic waste. We don't even know what we're doing to the environment because we really don't know that much about the environment to begin with. We're just haphazard. I feel we're a throw away society... There is a problem... an epidemic problem... let's start doing something now before we run into so many problems... But we won't. We'll wait.

Acknowledgement of Science

As a study in science education there was of course an interest in any mention of science and any indication that science significantly informed a student's view of nature. Only four students made emphatic comments about science. These included both naturalists (e.g., Carla) and theists (e.g., Mindy).

Carla: You can study nature and learn about it. I've had a lot of science classes I understand and chemistry. I understand the chemical principles of a lot of things. I understand how bacteria work in the ecosystem now that I've studied it. It's coming together for me. I understand what I've learned so far. I'm interested in anatomy, physiology... interested in how the body works... It's like a machine... I'm interested in nature. I enjoy microbiology, understanding how things work, not just on an molecular level, but, you know, on a higher level, too. I like to know how things work out there.

Mindy: There are mysteries but they're not infinite mysteries. Eventually we'll figure it all out. I believe nature was created divinely for our use and for us to learn and understand and be able to use the laws... As I continue my education, the more real [nature] becomes... the less mysterious it becomes... the more I enjoy learning more about it... As I'm forced by requirements to learn more in college about like physiology and anatomy... and it becomes more understandable and more real, like the synapsis are real now where they were nothing before... I didn't even know they were there... it makes me want to learn more...

Summary Observations

The causal examination of the students' belief space as described above reveals several points of interest for the science educator.

1. Nine of fifteen students had religiously influenced views of nature.

2. Seven of fifteen students indicated a concern about teleological question in nature.

3. Twelve of fifteen viewed nature as basically knowable. This includes six of nine holding religiously influenced views of nature.

4. Only four of fifteen transcripts showed the positive influence of science. Nine showed a weak influence while two showed no influence at all.

5. For the most part, knowledge of nature including scientific knowledge was mentioned in conjunction with the management or preservation of nature.

6. Fourteen showed a strong aesthetic, or otherwise special, view of nature.

Working Hypotheses

The following are inference summaries drawn from the data. They are statements and questions related to teaching/learning episodes and the players and materials in those episodes. The passages are working hypotheses from which new research and formal hypotheses can emerge.

1. The text shows a rich variation of conceptualizations of nature, only one reasonably matching the standard naturalistic-mechanistic view of nature. Does this matter in science education? What happens when heterodox views such as theistism and aestheticism meet in the classroom with the standard view? A suggestive aspect of the text is that there were very few remarks about science.

2. Elements of the text suggest what might happen during classroom interactions. When

science related remarks occur in the text it is typically about environmental knowledge or the aesthetics of nature. There appears to be more interest in relational knowing than in objective knowing. Though all of the students involved had successfully completed several science courses, in four of the ten text components there was no significant occurrence of science related concepts at all. It appears that within the cultural context of this group, the standard scientific view of nature has been reconstructed in significantly different forms.

3. In the text there are strong components of both theism and naturalism, neither of which is more or less likely to be associated with science components. This invites questions about possible relationships between science, religion, and philosophy. It also suggests caution in drawing conclusions about the relationship between religious beliefs and science as has been done in some quantitative studies (e.g., Lawson & Weser, 1990).

4. Two elements, arguably related, were found in most of the text components. One, aesthetics, is the conceptualization of beauty in nature. The second, preservation, is the conceptualization of nature in need of protection. One is reminded of the role of beauty in Japanese elementary science education.

5. What one does not find in the text components is of equal interest. Not all components include the conceptualization of a knowable natural world, knowable in the sense that one can study nature and thus acquire knowledge of it. This may indicate that some deem such knowledge unreliable, too arcane, or of lesser importance than other ways of knowing about nature. When knowable does appear it is often in a supporting role.

6. Related to the concept that nature is knowable is the concept that the natural world is orderly. This was another concept missing in some text components. The absence, or minimal presence, of these two elements coupled with a strong aesthetic presence implies an affective understanding of nature.

7. Despite what appears to be a significant disjunction between the student conceptualizations of nature and the standard view, these students were successfully preparing for a science-related profession. They were achieving success in what were typical science courses. This raises two issues. In this study, successful simply means that the students were passing their science courses at a level that allows continuation in the nursing program. Other than the reconstruction noted in "2," it is not at all clear how interactions of this group with science teaching might have resulted in various levels of scientific knowledge and attitude. The second issue is related to the group description. Is success a measure of their maturity? As adult, goal-oriented (nursing degree) learners, do they bring a sophistication that allows them to create meaning in a context that is in some ways fundamentally at odds with their own views of the world? Would younger students, or students oriented toward a non-science related goal, be less able to do this? This was a group of women. Are the conceptualizations, and reconstructions of the standard view, of nature as found in this study in some fashion typically feminine?

8. Finally, the text at points indicates growth. As students took science courses they began to be more aware of, and concerned about, problems related to pollution, life style, and the use of natural resources. Here is a area where science education was having the intended effect - but why? The answer may lie with associations that can be drawn between concepts of management and preservation and student understandings of the essence of nature, such as aestheticism. Other concepts from science education may not be so easily associated.

Conclusion

This study was an exercise in hermeneutic interpretation within an emergent design. The main objective was to come to a better understanding of the cognitive culture of a particular group, i.e., women college students preparing for a career in a science-based, helping profession. The data was sumarized in concept maps and narratives, the telling features of which were richness and rationality; yet only one set reasonably matched the standard naturalistic-mechanistic view of nature. Though at this time no formal comparisons are possible, there is the appearance that students bring to class a belief space that is general and inclusive, there to meet a curriculum belief space that is narrow and exclusive.

To summarize, it helps once again to return to the semiotic triangle of sign, object, and interpretant. These students when confronted with science and a standard signification do create meaning. The meaning with regard to the natural world, however, is dominated by concepts of relationship, management, aesthetics, and purpose. For the most part this group's conceptualizations of nature are not the standard interpretations of science, yet these people are far from being scientific illiterates. What we have is not another set of misconceptions, but a different contextualized of science. Jacques Monod (1971) once remarked that science has established its place "in practice, but not in the hearts of men... modern societies have accepted the wealth and power that science has opened up to them, but have not heard, much less accepted, science's most profound message -- that it represents a new and unique source of truth." While Monod's statement of it is undoubtedly extreme, his basic position is widely shared by science educators. But perhaps people are more aware of science than given credit for; and it is not science *per se* that they reject, but particular contextualizations of science.

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Appendix A: Elicitation Devices

Word Sort

The following three groups of words are used as a word sort elicitation device. Each word is printed on a 3x5 card. The informant is shown each group of cards separately and asked to divide the cards into two groups labeled "would use" and "would not use" with respect to nature. The interviewer combines all the "would use" cards into one group and the "would not use" cards into another. The informant is then shown these two groups one at a time and asked to preform a ranking task. As the informant ranks the cards the interviewer encourages the informant to talk about his or her decisions.

Chaos/Order

orderly	chaotic
knowable	mysterious
understandable	puzzling
steady	changeable
secure	dangerous

alternative words

balanced	unstable
reliable	variable
stable	volatile

Aesthetic/Materialistic

beautiful	firm
attractive	concrete
appealing	real
pleasant	solid
delightful	tangible

alternative words

enchanting	substantial
fascinating	perceptible
pretty	materialistic
wonderful	

Sacred/Prosaic

divine	ordinary
holy	common

sanctified	normal
spiritual	routine
special	prosaic

alternative words

purposeful	everyday

Statement Sort

The following three groups of statements are used as a word sort elicitation device. Each statement is printed on a 3x5 card. The informant is shown all 17 cards and asked to divide the cards into two groups labeled "would use" and "would not use" with respect to nature. The informant is then shown these two groups one at a time and asked to preform a ranking task. As the informant ranks the cards the interviewer encourages the informant to talk about his or her decisions.

1. I see in nature the work of God.
2. I find in nature a spiritual quality.
3. Nature is the result of purpose and things happen in nature because of purpose.
4. Nature is an everyday part of life that I generally do not think much about.
5. I see beauty in nature.
6. I have an pleasant emotional response to nature.
7. I view nature as something solid, substantial and reliable.
8. Nature is the material, concrete world around us.
9. The natural world is all there is, all there ever was, all there ever will be.
10. Nature is difficult to understand.
11. To me nature is mysterious.
12. Nature is something that should be studied so that we can learn more about it.
13. It is important to understand how things work in nature.
14. Nature is a very important resource: water, energy, food, materials for making things.
15. Without the things that we get from nature we could not enjoy the lifestyle we have today.
16. I believe nature needs to be protected.
17. I am concerned about pollution and the damage it does to nature.

Dyad Statments

1. Nature is important because it is the real world around me.
2. Nature supplies the energy and materials needed by people.
3. Nature is something substantial.
4. We study nature so that we can live more harmoniously with nature.
5. The more we know about nature the better we can understand our relationship with nature.
6. By carefully studying nature we are better able to control our natural environment.
7. Our first consideration must be the protection and preservation of nature.
8. Nature is important because it appeals to my sense of wonder and beauty.
9. We study nature so that we may understand how events in nature function.
10. Because nature is our environment, we must preserve it.
11. Our first consideration must be the needs of people that can be met by the resources in nature.
12. Nature has an enchanting quality.

Appendix B: Conceptualizations of Nature - Codes

Codes are of two types, Descriptive and Relational. Descriptive codes refer to information about what the natural world is like. Relational codes have to do with human relations with the natural world.

Descriptive Codes

D/Abstr: Abstruse - quality of being difficult to understand, complex, recondite; opposite of **Explicit**; related to **Mysterious**.

D/Aesthe: Aesthetic - a view emphasizing the wonder, awe, excitement, beauty of nature; may or may not include Fascination.

D/Authen: Authentic - as opposed to something manmade, artificial, or altered my man, can be an expression of **Realism**.

D/Change: Changeable - change occurs in nature but not necessarily chaotic or disorderly change. See **Chaotic**.

D/Chao: Chaotic - emphasizing chaos or random change in nature, uncontrollable events in nature, danger; a more extreme code than **Change**; opposite of **Order**.

D/Diverse: Diverse - indication that nature includes great or substantial diversity.

D/Dynamic: Dynamic - the co-occurrence of the codes **Changeable** and **Orderly** connoting change within order, orderly change, change through process.

D/Expli: Explicit - quality of being clearly understood or capable of being clearly understood; opposite of **Abstruse**.

D/Fascinat: Fascinating - quality of being attractive or appealing because of how nature works/functions, its systematic nature (as in ecological systems), symmetry; but not due to its beauty or harmony, for this use **Aesthetic**.

D/Inclu: Inclusive - an indication of nature including both physical and organic nature.

D/Know: Knowable - an expression that it is possible to have reliable knowledge and understanding of the physical world; related to relational codes **Education** and **Science**.

D/Limited: Limited - knowledge of nature is limited, incomplete.

D/Living: Living organisms

D/Materl: Material - material, physical nature of the natural world rather than spiritual or organismic; allows for elements of randomness and possibly **Chaotic**; compatible with **Naturalistic**, but can also co-occur with **Religion**; opposite of **Sacred**.

D/Mundne: Mundane - an expression of the routine, "matter-of-fact", quality of nature; opposite of **Special**.

D/Myster: Mysterious - unfathomable essence of nature, the inexplicable, may refer to the vastness of what is not known about nature; related to **Abstruse, Explicit** and **Knowable**.

D/Naturl: Naturalistic - a naturalistic view of nature as opposed to **Sacred**. Not compatible with the categories **Teleological & Theistic**.

D/Order: Orderly - emphasizing the orderliness of nature; opposite of **Chaotic**.

D/Past'l: Pastoral - quietness, serenity of nature, idyllic

D/Powerl: Powerful - nature has great force

D/Permn: Permanence - nature will always be

D/Pristine: Pristine - natural, clean

D/Purpse: Purposeful - mention of purpose (usually by the question, Why?), the purpose may be **Teleological** or **Teleonomic**.

D/Religs: Religious - a reference to God as the creator of the natural world, or the one responsible for the natural world, related to the code **Sacred**; related to the **Theistic** category; an opposite of the code **Naturalistic**.

D/Sacred: Sacred - a pantheistic view emphasizing the sacredness of, or organismic nature of the natural world; an opposite of **Naturalistic**.

D/Secure: Secure - resistant to damage and/or change; an opposite of **Changeable**.

D/Specil: Special - a vague emphasis on the specialness or uniqueness of nature, but without any implication of **Fascinating, Religious** or **Aesthetic**.

D/Spcreat: Special Creation - reference to a particular view of creation espoused by some fundamentalist Christian groups.

D/Teleo: Teleological - transcendent **Purpose** in nature, not necessarily Theism

D/Tnomic: Teleonomical - **Purpose** in nature based on function.

D/Theistic: nature dependent on God; excludes **Naturalism**, implies Teleology

Relational Codes

R/Contro: Control - human control over or manipulation of nature; related to **Knowable** and **Order**.

R/Educat: Education - specific reference to formal or informal education; related to **Science** and

Knowable.

R/Emot'l: Emotional - an emotional response to nature, reference to strong feelings.

R/Histor: History - events or situations of childhood and growing up years, as well as those in later years.

R/Growth: Growth - an indication of personal growth such as a change of attitude toward the environment.

R/Health: Health - supports good health

R/Integ't: Integrated - an indication that everything including people is integrated with nature.

R/Intru: Intrusion - specifically people acting upon nature in a negative way (may be implied), resulting in the polluted state of nature; related to **Preserve**.

R/Lifestyle: Lifestyle - nature influences one's lifestyle

R/Manag: Management - the co-occurrence of the codes **Resource**, **Preserve**, and **Knowable**. Connotes an intended balance between Resource and Preserve.

R/Media: Media - the mention of TV, film, etc.

R/Outdoors: Outdoors - indicates that one spends time out of doors hiking, camping, etc.

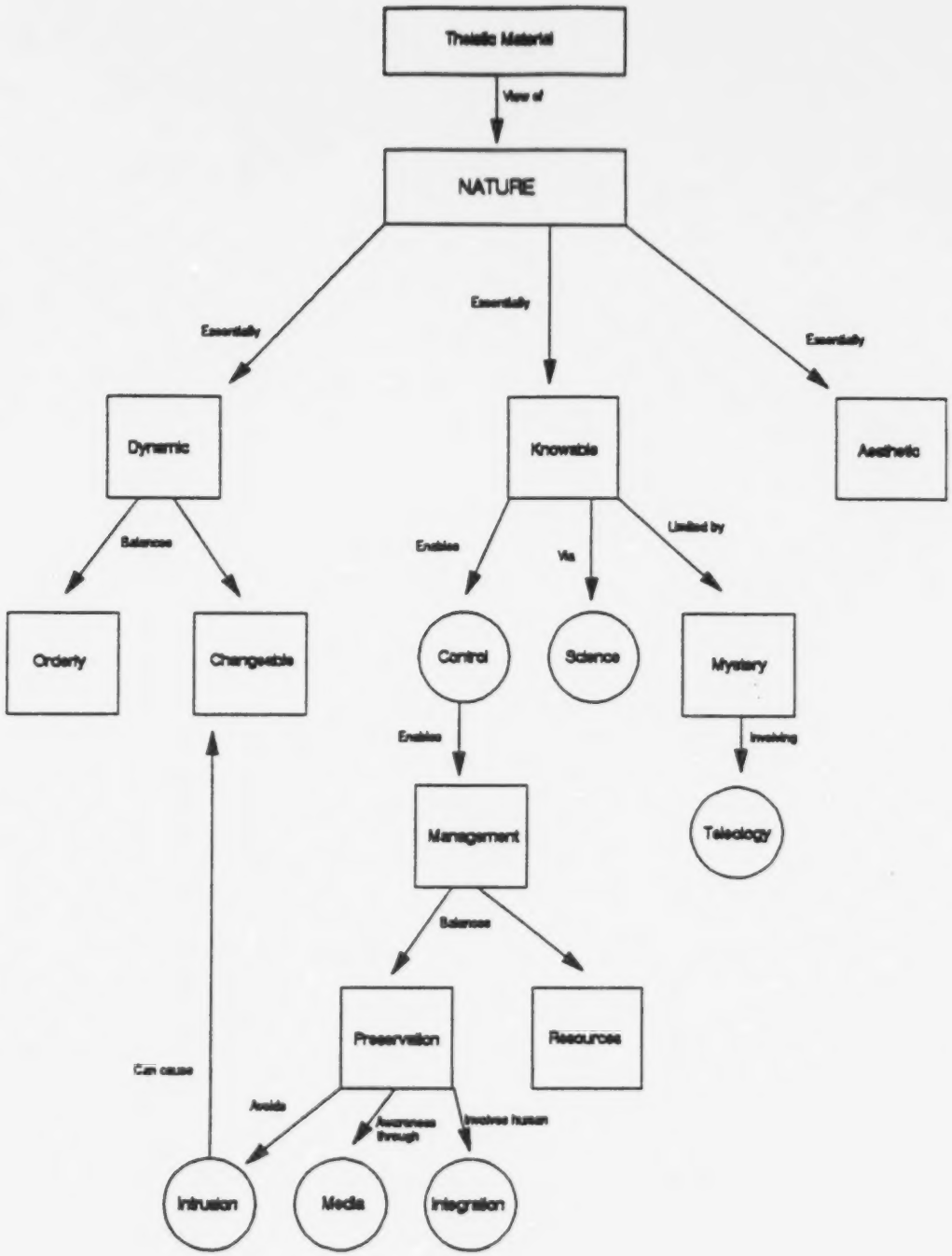
R/Powless: Powerless - a feeling that one is powerless in the face of nature, or powerless to do much about what is happening to nature.

R/Preser: Preserve - emphasis on the need to preserve nature, employ conservation; related to **Resource**.

R/Resour: Resource - nature is a natural resource, related to **Preserve**.

R/Scien: Science - specific reference to scientists or the formal study of science; related to **Education** and **Knowable**.

Appendix C: Concept Maps and Narratives



Conceptualization of Nature: CASE 1

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Interview #1: Amy
Summer 1990

A. Nature is the material world *created* by God.

I feel nature is the real world around me (865). I perceive nature to be unartificial... genuine... it's to be considered genuine or authentic... As opposed to plastic (245-253). I feel God had a hand in nature. He really pushed the first button and let everything else take its course (230-236).

As such Nature is *beautiful.*

I don't think nature is ordinary. Nature might be orderly and routine but it's not ordinary, but extraordinary (374-377). You know, good or bad, even a tornado, is beautiful from afar, nature can be beautiful when... it's not so much fun (259-269).

B. Nature is a *dynamic* system of *order* and *change.*

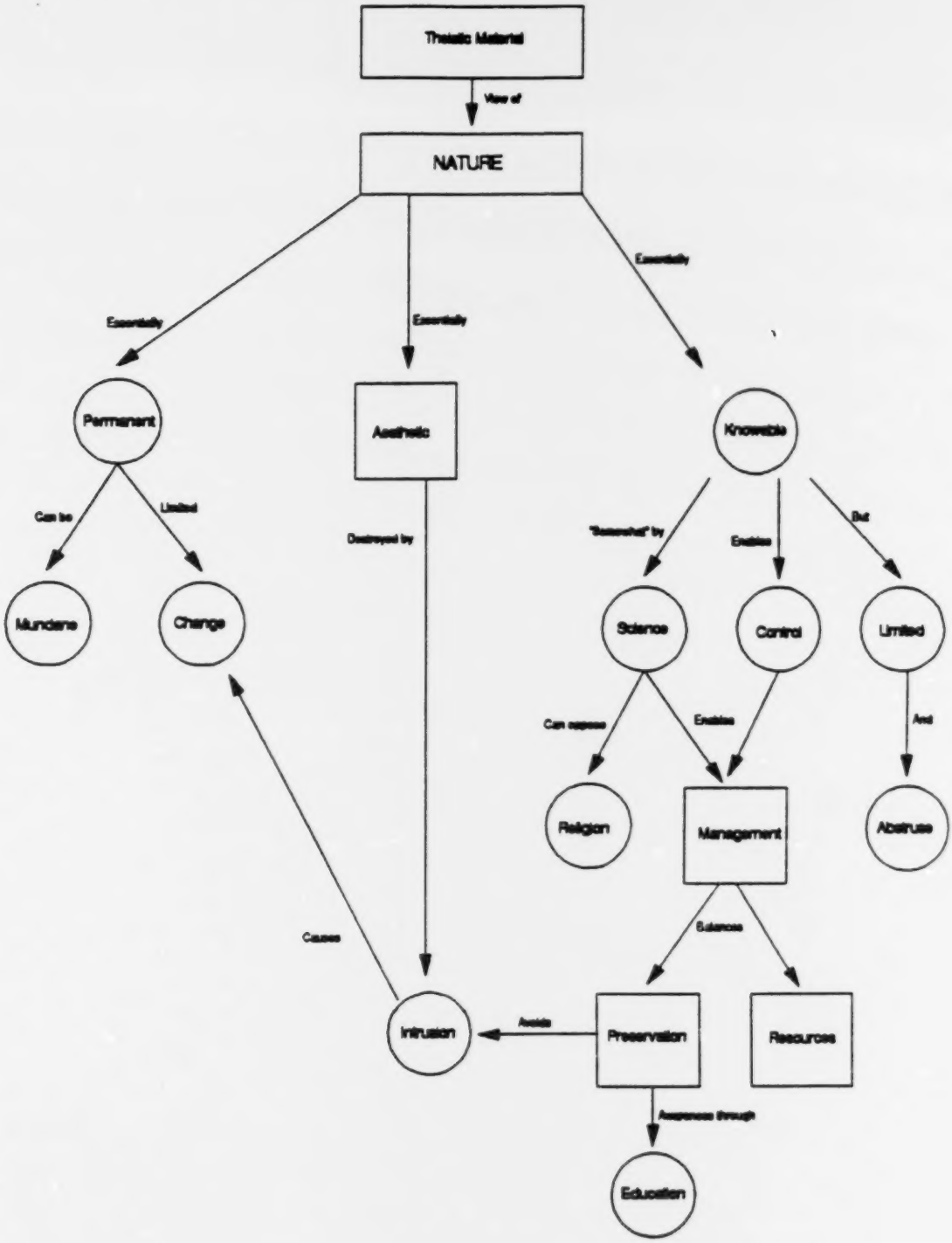
Let mother nature do her thing. If we two-legged creatures can keep our nose out of her way, nature is very orderly. There's a reason for it all (170-179). I feel there is an orderliness in nature being left untampered... Where there is a flood or forest fire or something it's normal. It's just nature's way of taking care of itself. I don't think there's anything chaotic in nature. Individual phenomena might be viewed as chaotic by we humans but I don't think in the field of nature that there is anything chaotic involved (311-335). But nature is constantly changing. It's not necessarily going to be the same tomorrow or next week or next year as it is right now (623-627).

C. Nature is *knowable* but knowledge is limited by *mystery.* Even when one *knows* about an event, often one does not know *why* it happens.

To me nature is mysterious and difficult to understand (566-569). I think nature is knowable... not understandable necessarily, but knowable... You can know that the tide is going to come in at such and such an hour... can predict it... you can know that the moon is going to have a pull and help cause that phenomena, but I don't claim to understand why... somebody could tell me it was the fog on the corner that made the tide come in ... it's just being able to totally understand why something is and know that it happens. I know my husband loves me but I don't know why (274-304). Only mother knows why... a lot of things happen... a lot of it is just mysterious... kind of like... you take a lot of things on faith and your religion and you do with Mother Nature too (186-202). You can understand if a forest burns it sort of creates the fertilizer for new strong trees, it gets rid of the sick, dead stuff and lays down the level for the propagation of new trees and grasses. I have a girlfriend who almost lost her home because of Mt. St. Helen's. She was relatively close and I had trouble understanding why: #1 people had to lose their lives... #2 It was such a pretty mountain. I had trouble understanding why it had to cease to be (574-597).

D. Perhaps the most significant aspect of nature is that nature is the one essential *resource* for people. Therefore, nature must be *protected* from damage and pollution. The protection of nature requires the knowledge about nature that comes from study.

If we don't preserve our environment, we won't be able to meet any of the needs of the people. It's one of those things. Which came first? The chicken or the eggs. But I think we need our resources available and in order to do that we have to protect the environment... we must preserve our environment (804-814). But, we have to know how and the only way to do that is to study... We study nature so that we can live more harmoniously with nature. If we don't study and learn more about nature, know all we can, maybe not understand but know all we can, and be concerned about pollution, we won't have the trees to build our houses and the forests for our wildlife and everything will come to a screeching halt. We'll be back to caves (550-562).



Conceptualization of Nature: CASE 2

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Interview #2: Billie
Summer 1990

A. Nature is the *material* world originally made by *God.*

Nature came from God (272-275). I do believe that God is behind nature. Nature is the result of purpose... the purpose of God (599-603). I see in nature the work of God. In fact, I just feel like He created everything. I feel like that's a fact (680-691).

B. Nature is *beautiful.*

I think just nature in general is beautiful because of all the things that make up nature (199-202). Nature is attractive. It makes people want to... me anyway... want to get there and get away from the city and go into nature... Nature is more beautiful... you can sit back and say nature's beautiful in general. It's attractive... you want to get in it (260-268).

C. One can have *limited knowledge* about the natural world which is very complex and often *difficult to understand.*

I just think it's really complex. It's difficult to understand... I can't quite understand it (806-811). I think there is order in nature but how does anybody know how the order supposed to be (429-434)? Nobody knows it all about nature (326-330). There's always something new you might find in nature (245-249).

Scientific knowledge at times may oppose religion.

I had a religion teacher... and he didn't believe that God created nature and we went round and round. And I didn't have a lot of facts behind me like he did. He was very scientific and articulate (693-704).

D. There is a *permanence* about nature and limited *change.*

Most people think it will always be there and I do too (293-296). Nature changes itself over the years... and the decades (234-237).

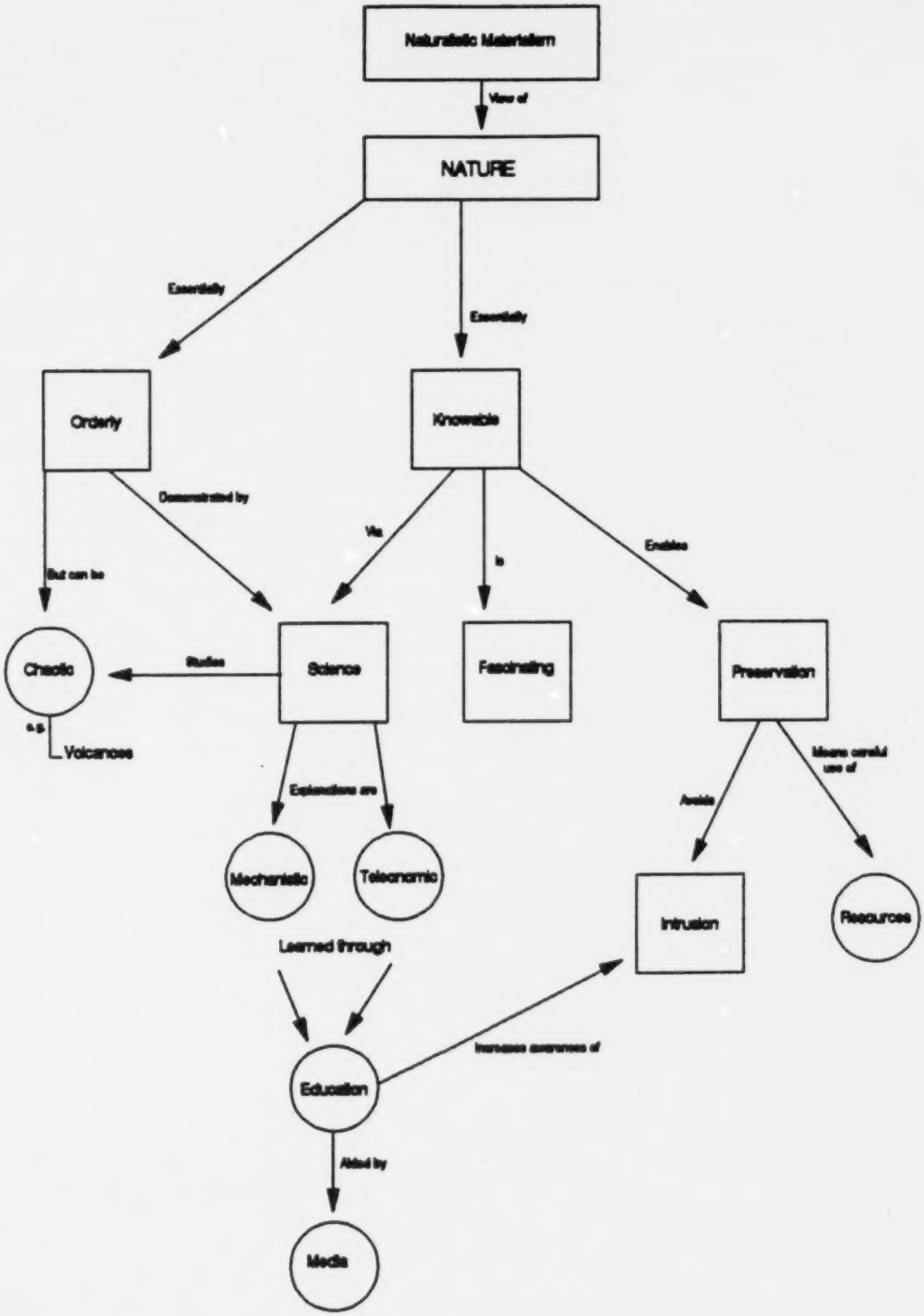
People *intrude* and adversely change nature but this is something education can help.

People can change nature so much. I mean, you know, the things individuals do or, you know, atmosphere, too. Mostly what people do can change nature a lot (223-228). Yes, nature is important because it is close to my sense of wonder and beauty... but it's not going to appeal to your sense of wonder if it goes bad (913-929). If we study nature or if nature is taught in schools a little bit more, I think, people would become more aware of nature.

E. The study of nature enables the *control* and *management* of nature which involves the balancing of resources and preservation.

Nature is a very important resource: water, energy, food, materials for making things. There's lots of things that we get from nature... water, we get everything from nature. Water, land, it brings us everything (737-749).

If we don't understand how things work in nature, then we can't appreciate what we have and then we don't know what we've lost if it goes. We study so that we can understand. So we know what to do to help and to keep nature sustainable... something that is ... forever (751-775).



Conceptualization of Nature: CASE 3

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A. The *natural* world is the only reality there is.

I think of nature as everything that pertains to the planet. It arises from the planet. That involves the air we breathe, the oceans, the earth itself, the land, the living organisms that inhabit it (28-35)... animals... flora... fauna... minerals... weather phenomena ... I think it's everything (780-788). A religious person would say nature is there for a purpose. God put it there for a purpose. I don't think so. I'm an atheist (813-841).

B. Nature can be *understood* through *science*.

You can study nature and learn about it (505-507). I've had a lot of science classes I understand and chemistry. I understand the chemical principles of a lot of things. I understand how bacteria work in the ecosystem now that I've studied it. It's coming together for me. I understand what I've learned so far (307-323). I'm interested in anatomy, physiology... interested in how the body works... It's like a machine... I'm interested in nature. I enjoy microbiology, understanding how things work, not just on an molecular level, but, you know, on a higher level, too. I like to know how things work out there (953-970).

The study of science and nature is *fascinating*.

I think the way everything comes together and... is synchronized with everything else... that fascinates me. I just think that's terrific (296-303). I think animals are appealing to me... their interaction... how they act in family groups... particularly the primates are so much like humans. It's appealing to watch them (357-363).

C. *Order* in nature is revealed by science.

I'm a science major and... it's everything I've been taught that everything has an order to it... a system to it (230-235).

Some phenomena in nature are *chaotic*.

Nature is orderly, but it can be dangerous... there are phenomenon that are dangerous phenomenon... volcano eruptions, earthquakes (259-289).

D. Nature is an important *resource* but it must be *preserved* and *intrusive* behavior avoided.

Nature's a very important resource.... water, energy, food, materials for making things... but we're contaminating our ground water... nuclear energy... I think it's a good thing, but, you know, the possible ramifications are scary... Chernobyl is a good example. Food. I'm kind of anti-fertilizer. I realize that it's important for food production... money's the name of the game... but, you know, by the same token, you know, it's ruining the soil. I'm concerned about that (639-655). I'm concerned about the ozone layer, the Brazilian rain forest, as I learn and study more about these things and their potential effects of damaging them that scares me. You know, I find that very scary. I'm a bit of an environmentalist and I think that if we're not careful, you know, we're changing our planet and for the worst (334-340).

Education can help:

I think if you're more educated in how things work, you're probably less inclined to abuse your environment. I think you have to educate people... we don't grow up knowing these things. I believe education is the key (726-739).

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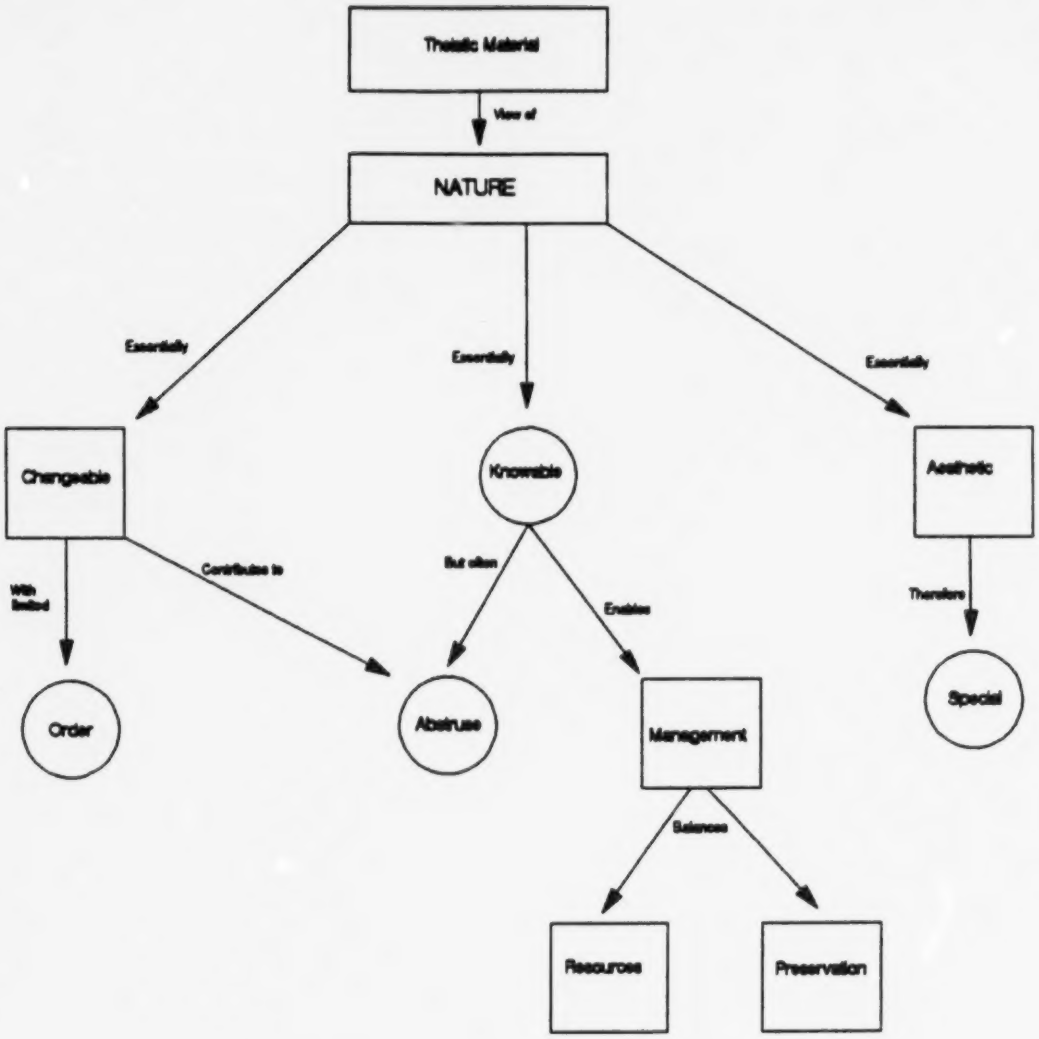

Conceptualization of Nature: CASE 4

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Interview #4: Denise
Summer 1990

A. Nature is the *material* world originally made by *God.*

I believe that God makes everything (161-165). Nature is the result of God (500-501). You can't really fake nature because it is really real. You can't pretend an earthquake happened (177-189).

In a sense, the natural world is ordinary. It is the everyday world around us.

People say, "Oh, nature is just an ordinary thing" (300-304).

B. When I think about the natural world, the quality that captures my attention is its *beauty.*

Lots of things in nature... flowers and trees and animals are delightful... everything around us is delightful (125-141). Nature is pretty... it is special because it's so quiet (207-211).

C. The natural world is *changeable.*

Manmade things are orderly... but not nature (219-221). Nothing is really solid, nothing is really for sure, you know... an earthquake or something... you're not sure tomorrow's going to come (269-273). Things don't always happens the way we think they're going to happen, so it is not orderly the way manmade things are (329-339).

D. Nature is not mysterious, but the changeableness of nature can make it *difficult to understand.*

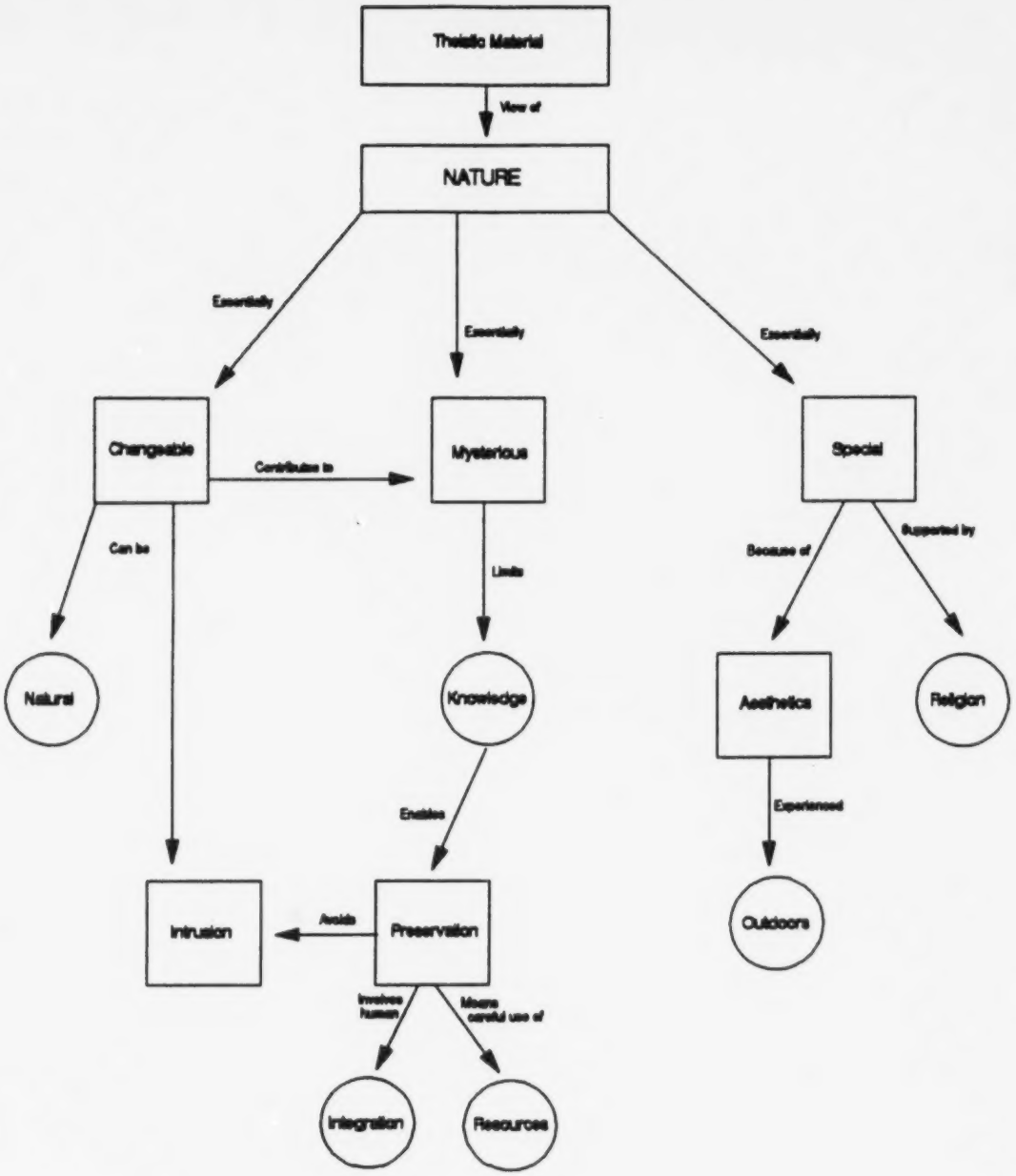
Nature is not mysterious to me because of the fact I believe God really made things (447-450). It's not always puzzling, I mean... there's a reason for everything (360-362)... but, I don't really understand the stars and the moon, and all that, for example (150-159).

E. Knowledge about nature enables the *preservation* of nature.

Nature is something that should be studied so that we can learn more about it... but your studies would be aimed at how to protect nature (479-483).

We must protect the natural world and conserve *resources* for future generations.

[I think about nature] because I have my kids... in order to have [the resources of nature] we need to protect nature (468-483). We probably could do without some things [that we get from] nature (459-464).



Conceptualization of Nature: CASE 5

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Interview #5: Elizabeth
Summer 1990

A. Nature is the *material* world originally made by *God.*

Nature was put there by God (777-785). I see in nature the work of God. The Grand Canyon... something so outrageous... things that are beautiful are usually the work of God but you cannot say things that aren't beautiful are not the work of God, but I think the most spectacular things in nature are beautiful and the work of God (522-548).

B. Nature is *special.*

Nature is special and there's a place for it... But I think people are taking advantage of what is out there and I think nature should be preserved... I don't think, you know, buildings should be put up... parking lots and all that sort of thing (203-215). I think most symbols of religion... have to do something with nature. It shows that most religions respect nature somehow (258-263).

The *beauty* of nature is partly what makes it special.

I think everything in nature is beautiful and I haven't seen anything I really dislike... being out here in the desert there's a lot of... nature. Everything is beautiful (145-155). Nature really affects you (231-240). My favorite thing to do is to go camping (882-887).

C. In nature there is natural *change* and intrusive change.

I think nature is always changing. Nature adapts (430-444).... As nature is settled by man the animals and nature still survive somehow... they change their habitat and find ways to coexist with us (267-275). Change can be good, but it depends on which way its changing (430-444). You might have a drought... but I don't think that's not as big a problem as man himself (374-378).

D. Nature is *mysterious.*

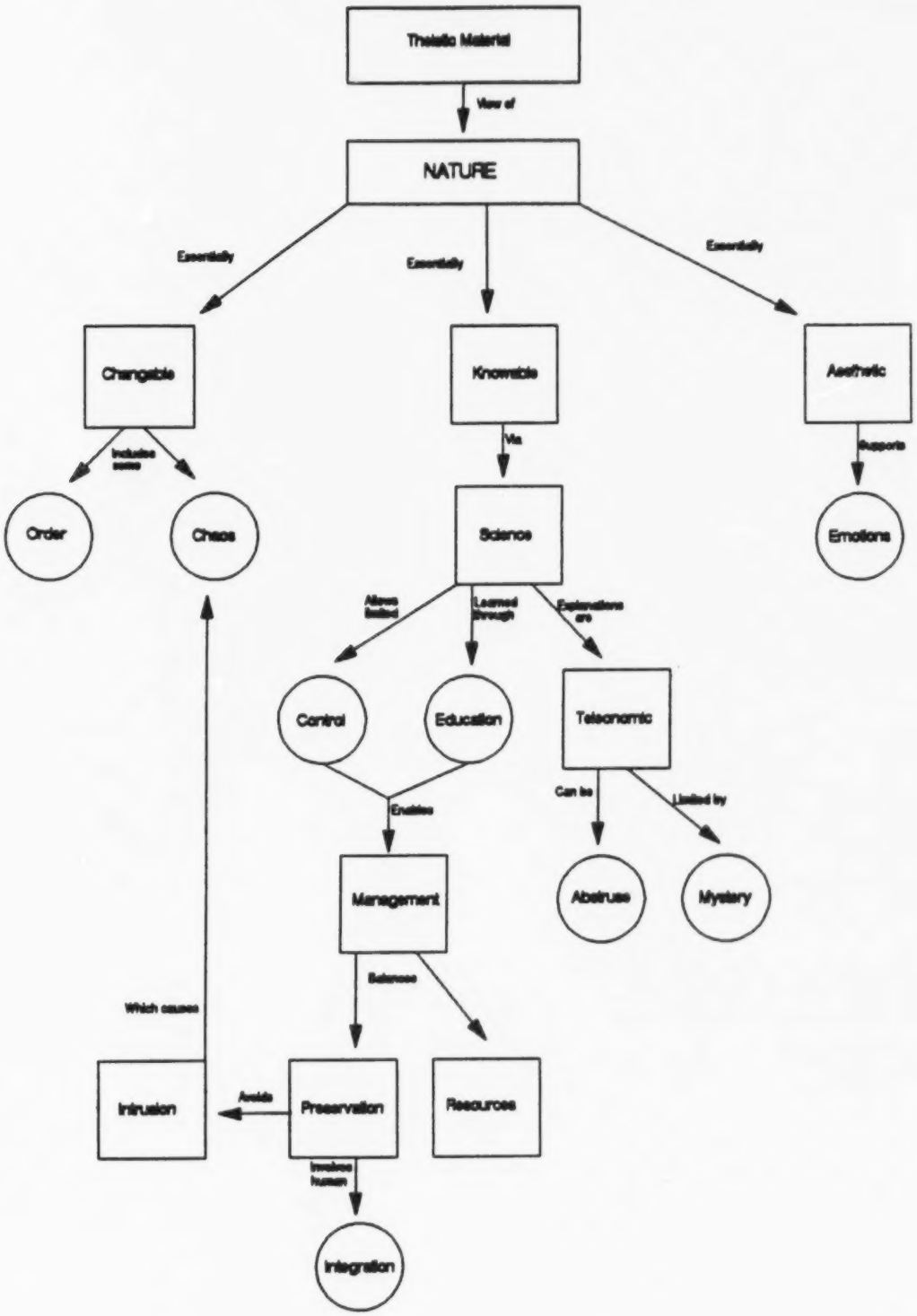
I don't think nature is knowable, I mean... it's totally unpredictable... everything about it's unpredictable... well, there's too much to know. I don't think you can say you know nature... everything about it has some air of unpredictability... maybe you can become familiar with it but not maybe totally understand it (340-357).

E. It is possible to have limited knowledge of nature which enables us to *preserve* nature and to live harmoniously with nature.

It is important to understand how things in nature work. That way we can know how to preserve it without taking advantage and destroying it because we're unaware of what our actions do to nature. We learn by observing what the results are of our actions... Keeping track of where our waste goes and what it does (554-570).

Nature is an important *resource* but man's behavior has been far too *intrusive.*

If it weren't for nature we wouldn't have hardly anything (603-605). Nature provides so much for use... oxygen... trees, food, everything (217-221). If we destroy and lose nature we're going to be in big trouble. We're not going to have fresh water, oxygen, you know, food (579-589). But I think man is taking advantage... they're more greedy for money than wanting to preserve what's out there right now (363-369). I think industry is out pacing nature's ability to regenerate (412-416). We are like totally robbing nature... for our own needs rather than treated it well (606-610). I don't think God provided Nature for us to totally destroy it... to use it for our selfish needs (834-841). I don't think you have to have all these materialistic things to enjoy your life. You know, I have never been rich or anything. I've always been happy though (889-894).



Conceptualization of Nature: CASE 7/#6

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Interview #6: Flo
Summer 1990

A. Nature is the *material* world originally made by *God.*

I believe in God and I believe that He created nature (340-347), but nature is not religious (599-610). If you see a sunset, you see God... but I know there is a reason for the sunset... I see, for example, biological reasons for things, not the work of God (1006-1020).

B. There is an *aesthetic* quality about nature that is *emotionally* supportive.

Nature is physically attractive, appealing, beautiful, pleasant, special... These words all take like happy meanings to me (230-235). Nature is aesthetically pleasing, it's something that makes you happy. For example, a sunset... I like sunsets over the desert. I like to go camping. It's fun and I enjoy it (249-261). I used to go camping with my family a lot when I was young... camping with my kids... whenever I see nature I think about times I've had with my family (701-706).

C. It is possible through *science* to have *knowledge* about nature.

Nature is something that's tangible... it's something that you can understand. It's there. Something to think about (174-178). I don't think nature is difficult to understand if you have knowledge and resources to understand it (1028-1031). There is a way to find an answer to the majority of your questions about nature (334-340). You can find out through biology and all the rest of the sciences (306-318).

Ultimately our knowledge it limited.

You don't know the reasons why some things happen, like natural disasters. You can question all you want. You can find out through biology and all the rest of the sciences but it's still a mystery to the people in those areas (306-318). There is a way to find an answer to the majority of your questions... like a stomach illness isn't mysterious because all the questions are answered, but if you have a question like why it rains on a particular day... well, its just your own religious belief (334-347).

Learning about nature allows for the *management* of nature which can be learned through *education.*

It's important to understand how things work in nature and nature is something that should be studied so we can learn more about it. And that's education... and how nature can work as a resource... how it can be abused and how it can be destroyed (863-872).

D. Nature is *changeable.*

Nature is not concrete. It's not something set in stone... it changes... Nature is always changing... things can affect it (444-457). It's something that changes everyday... anything can change it... it's not going to be there forever (920-926).

There is some *order* in nature but it can also be quite *chaotic.*

I know there are some patterns underlying nature (483-484)... you have some control but most of the time you have no control over nature. It is something that affects you. Natural disasters happen... or rain on an afternoon that you planned a picnic. It's just something that affects... it can throw chaos into your life (289-302).

Change can be brought about by the intrusive behavior of people.

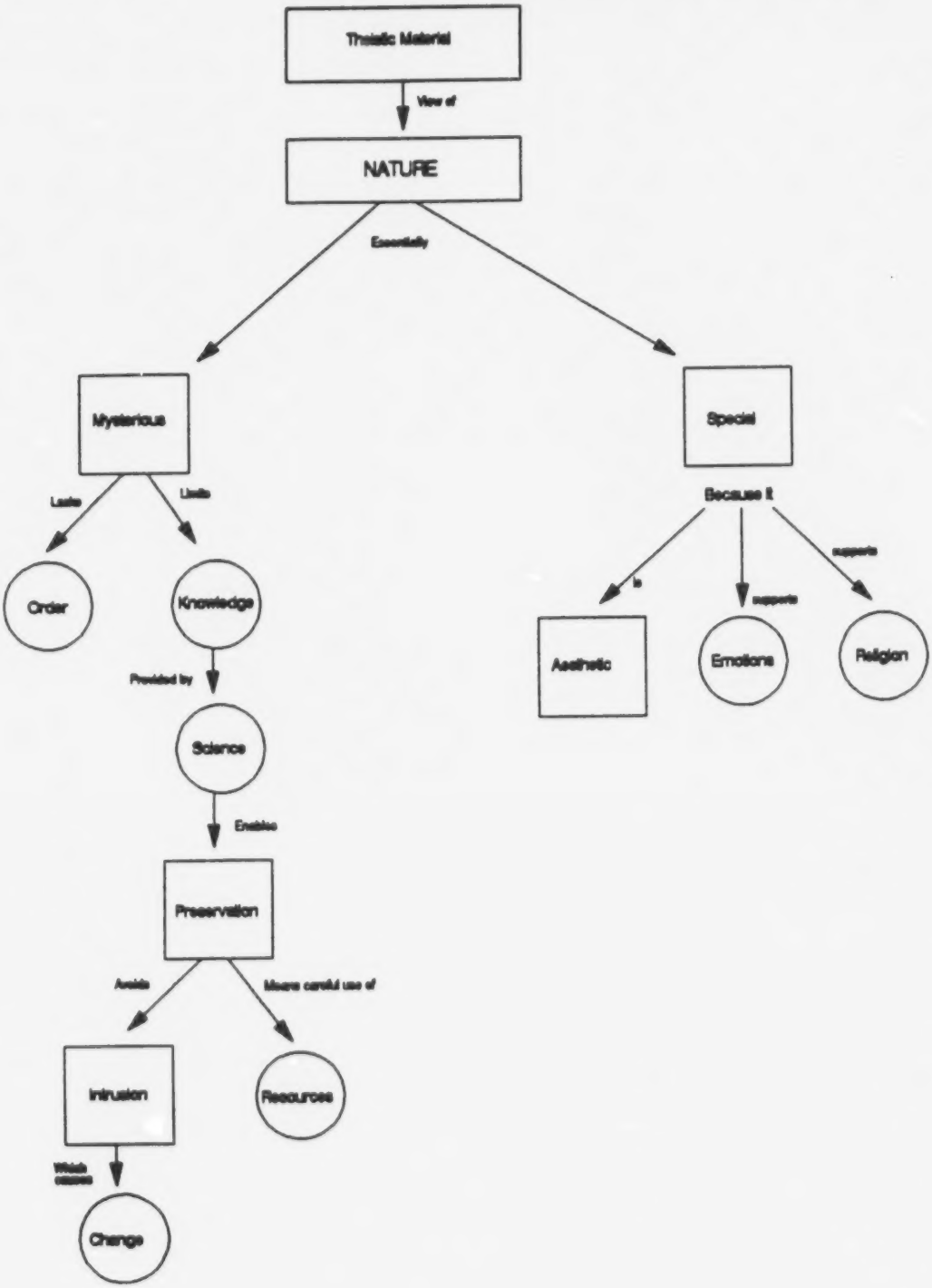
Nature is something that changes day to day. You have control over it... some control over it, but the thing that you have to keep in mind is the way you treat it... because nature can change depending on how it's taken care of (208-223).

E. The *management* of nature involves the balancing of *resources* and *preservation.*

> Nature provides the materials we use for furniture... cotton, fiber... food. I think everything you eat and own comes from nature somewhere... Without nature we wouldn't have comforts (774-828). You have to balance out your resources without cutting into your supply and not ruining your supply by spending your resources too much. Give and take between the two. You know, you can protect it to a point where no one can use it as a resource or you can use just a little bit and replenish it (844-854).

But there is a problem with *pollution.*

> I believe nature needs to be protected from dumping... pollution. Just the waste that's happening. We may not have clean water to drink. I mean, you don't have that now. Glendale water is atrocious. There's a reason for that (742-756). We tend to abuse... nature ... just to stay comfortable, so we stay in our cars instead of riding bicycles (824-828).



Conceptualization of Nature: CASE 8/#7

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Interview #7: Georgia
Summer 1990

A. Nature is the *real*, natural world *created* by God.

I just think of nature as just being something real and something unchanged (374-378). It's a place that God made... natural (531-536). I just feel that God initially created everything or at least had the design in mind (1249-1252).

B. Nature is very *special*.

Nature can be beautiful (462-485). I don't feel that nature is always beautiful or pleasant... it's not always delightful... but it's a place that you can always feel spiritual... close to God and close to your own feelings (320-330). It's a special place that God made (533,534). It's relaxing and helps you put things in perspective (1230-1235).

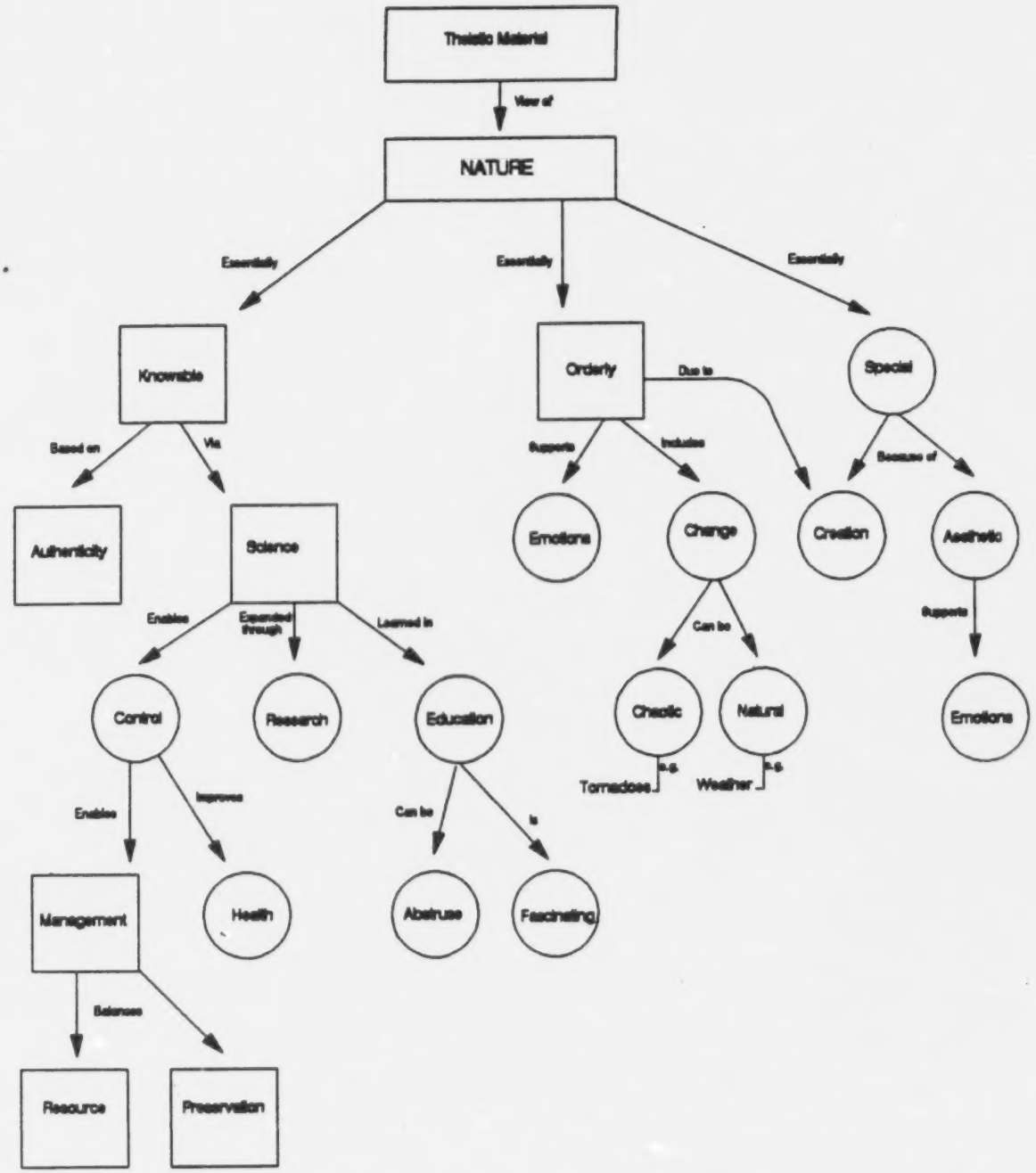
C. Nature is *mysterious* and our knowledge of nature limited.

Order in nature would mean patterns or something and that's not how I think of nature. I just don't think of all of nature as being a pattern (714-724). I wouldn't say that it was knowable or understandable... because we don't know everything about it or understand everything about it. I don't necessarily think that anybody knows or understands everything about nature (858-895).

D. Nature should be studied so that we can understand how things in nature work. This is done by scientists (1139-1172).

E. Though nature is an important *resource*, it must be *protected* and *preserved*.

I would say that nature is an important resource (1180-1181). Unfortunately, I think nature is very changeable... because, man can go in and tear down the forests or do whatever... put his needs there... or use the forests for his needs (496-508). Man is constantly changing nature (702-705). I am concerned about pollution and the damage it does to nature. I believe nature needs to be protected (1122-1133). We protect it so we can still continue to get our resources from nature (1201-1203).



Conceptualization of Nature: CASE 12/#8

Interview #8: Helen
Summer 1990

A. Nature is the *creation* of God and everything in nature exists for a *purpose*.

I have a strong faith in god and I believe that all this real stuff was made by God (493-502). Nature is God's work not man's work... whatever is natural as far as God making it before man touched it (54-60). I believe nature is real... that everything is for a purpose... it all goes back to a divine purpose... nature is a work of God and its purposeful (969-977).

B. Because God created nature, nature is *orderly*.

Nature is a work of God (975). I'm finding that everything is orderly... like we need maybe a chemical to make something else work but it all has to be orderly and work together, I mean, even minutely, so that's another thing that's being impressed on me right now (424-432).

Nature is pretty predictable (553-572). It's orderly and you know what you can expect. If you do such and such, you can expect such and such to happen... it is because it all kind of works together. We have to have certain chemicals in our body... or, there may be salt in the earth because we need it for our body. I believe everything's orderly but it's for a reason... our survival... but it was through a divine thing that everything happened to be that orderly. I don't think it was happenchance (1006-1049).

The order in nature is *emotionally supportive*.

When I think of nature I think of something strong (671,672). Nature gives me a secure and steady feeling knowing that there is such a rhythm in nature and that things are so orderly... it gives me a secure feeling about it (647-655).

Nature is *changeable* in the sense that there are processes in nature as well as natural disasters.

The weather changes... a tadpole changes to a frog... but that's not really change but process (579-588). There is destruction in nature (75-79). Nature takes care of us but nature can also take our life, like poisons, the weather, etc (677-689).

C. Nature is the *real,authentic* world around us and through science it is possible to have *knowledge* about nature.

Nature is the real physical world... we can test it and see what cells are in it or we can physically deal with it and learn about it so that's real to me... it's not an abstract thing necessarily (366-377). We have to dig down to get to it... through chemistry or biology or, you know, scientific methods... scientific study (866-880).

We're finding out more things all the time (553-572). I mean, there are a few things we don't know but we have an inkling of why they are that way and we're getting closer and I don't think nature is such a mystery anymore as what it used to be (604-612). Through research we're finding out so much and I don't think there's too much that's going to be left unknown eventually (659-665).

Science can be learned at *school* and it can be *difficult* to understand at times, but it is also *fascinating*.

Nature might be ordinary in the fact that we see an oak tree every five miles or whatever but it's not ordinary in the way it's made or the way it all works together, like the oak trees supports the worms or the birds... as far as I'm concerned nothing in nature is common or ordinary (736-746).

D. Science helps to improve the quality of *health*.

Just like something we were talking about in biology the other day... quadriplegic ... they're finding that they can replace the damaged tissue... to repair it, you know, and that's just a new thing (1099-1113).

Science also helps us to *control* our environment so that we can better *manage* nature.

Science also helps us to *control* our environment so that we can better *manage* nature.

> We study nature also to control our environment as far as waste and that sort of thing... to make our life better (1099-1113).

The *management* of nature involves balancing the use of *resources* and the *preservation* of nature.

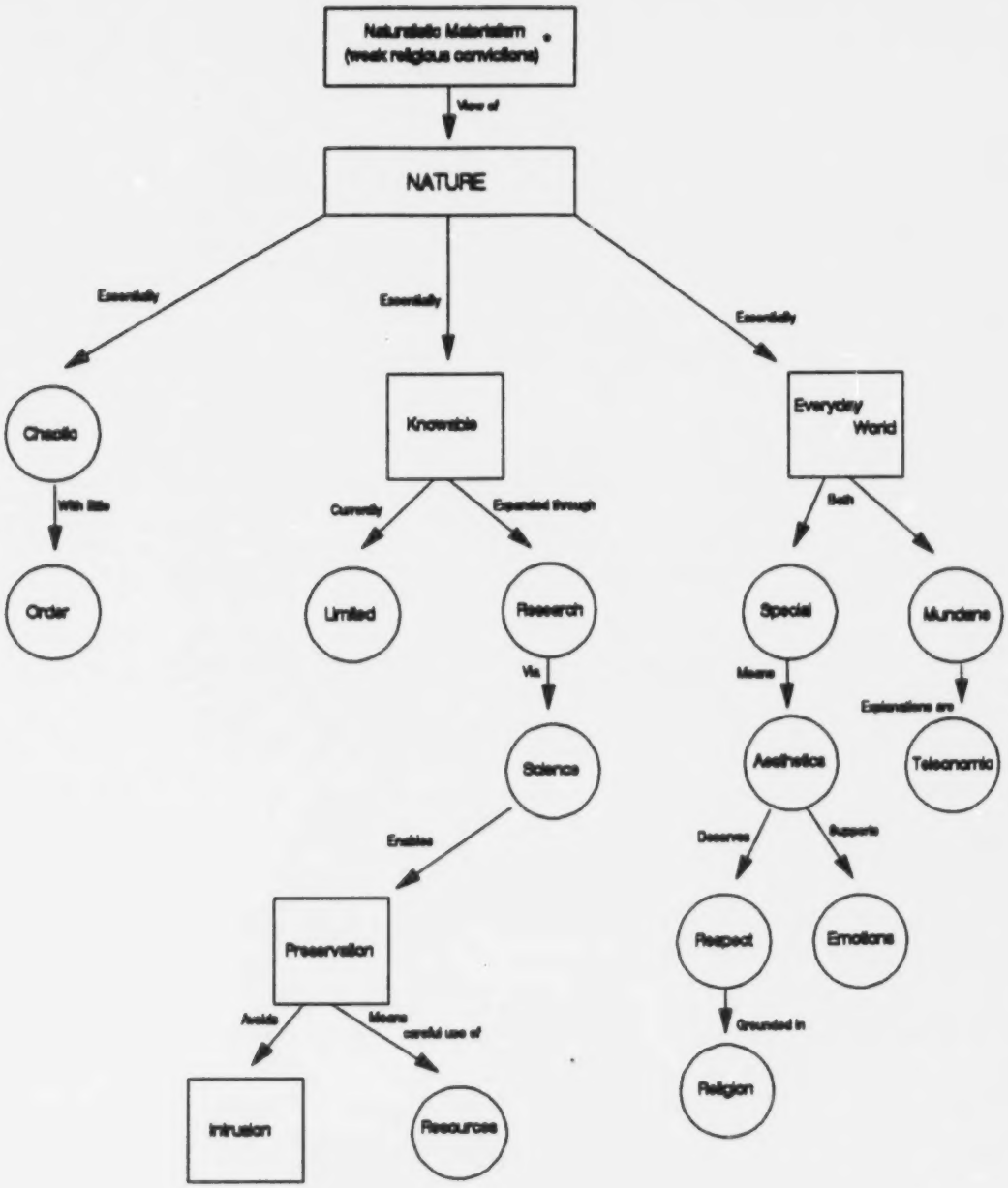
> Nature is a necessity to begin with... equally, nature needs to be protected. If we don't protect nature we won't have it as a resource (1147-1201).

E. Nature is *special* as God's creation.

> I believe that everything that is made and the way it was made is very special (508-520). Nature might be ordinary in the fact that we see an oak tree every five miles or whatever but it's not ordinary in the way it's made or the way it all works together (736-746).

It is also special for its *beauty*, but this is of lesser importance.

> I see beauty in nature and I have a pleasant emotional response to nature, which is a natural human feeling (1206-1212). We enjoy the shade of the trees, the water in the creek... the openness in the desert (638-643)... but, I don't think the beauty is as important as the functional part of nature. It's just from the childhood that I was reared in. It's like you don't have to have steak; you can have hot dogs and still get along. That's the only thing. It's not that you don't have to have the aesthetics but you do have to have the functional part (1218-1227).



Conceptualization of Nature: CASE 13/#9

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Interview #9: Irene
Summer 1990

A. Nature is the *everyday world* around us.

Nature is there... you think of nature sometimes as being... the mountains and running streams, but nature is all around us (450-457). You can touch and feel nature (1087,1088). It encompasses everything (29,30).

Nature is both *ordinary* and *special*.

You deal with nature every day even though you don't think about it. It's like a grasshopper I killed in the bathroom. You know, that's just everyday nature (436-443). [In nature] there really isn't an answer to why questions. Sometimes things just happen because they happen and you can't rationalize why they happen and no matter how much information you get... some things just happen (1050-1057). Sometimes there is no rhyme or reason... You can have two people standing on the same corner and one will have an accident and will be killed and then the other one nothing happens or a tornado is a really good example. Why does it touch down in one section of town and tear it up? I've seen that... where one house has been totally destroyed and the house next door there is absolutely nothing wrong with it (290-313).

When I think of nature I think of outdoors (40-44)... just sitting by a stream and watching the water flowing over rocks (821-823). I think of nature as being alive, vivacious (255-258). I think when you get out, you can get away from a lot of stress... you can just relax and enjoy what's around us (988-995).

I believe in a higher power... we shouldn't take nature for granted. We should look at it as being special and take care of it and preserve it and look at it in high regard (531-543).

B. It is possible to have *knowledge* about nature.

You can pull information about nature... not just from one source, but many different sources to understand the big picture (358-363). There is so much unknown about nature... there's so much knowledge and things to be explored (220-223). I just feel there is so much to learn... especially like with the oceans and there's so many things to explore (759-762). I think we've just hit the tip of the iceberg when it comes to nature. I think we can make great strides (234-243). I think if we take the time to understand nature we can (1021-1022).

C. Our knowledge of nature is *relational*. We study nature so that we can live harmoniously with nature.

We study nature so that we can live a little bit more harmoniously with it. Rather than trying to destroy it all the time... work with it. I think we sometimes wait 'til there's a problem... we do things and then we study about them... like with animals. We'll bring animals into a certain area to... like with the burros up in the canyons and how much damage they've done to the animals that were there and the environment as it was... there was a balance there... and now the balance is taken away (882-906).

Living with harmoniously with nature means *preservation*.

For the most part I think most people want to do their best to help with the natural environment and take care of it... I mean, that's everybody's ultimate goal, but we can only do the best we can and if each of us just does a little something it helps with the whole basic picture (633-650).

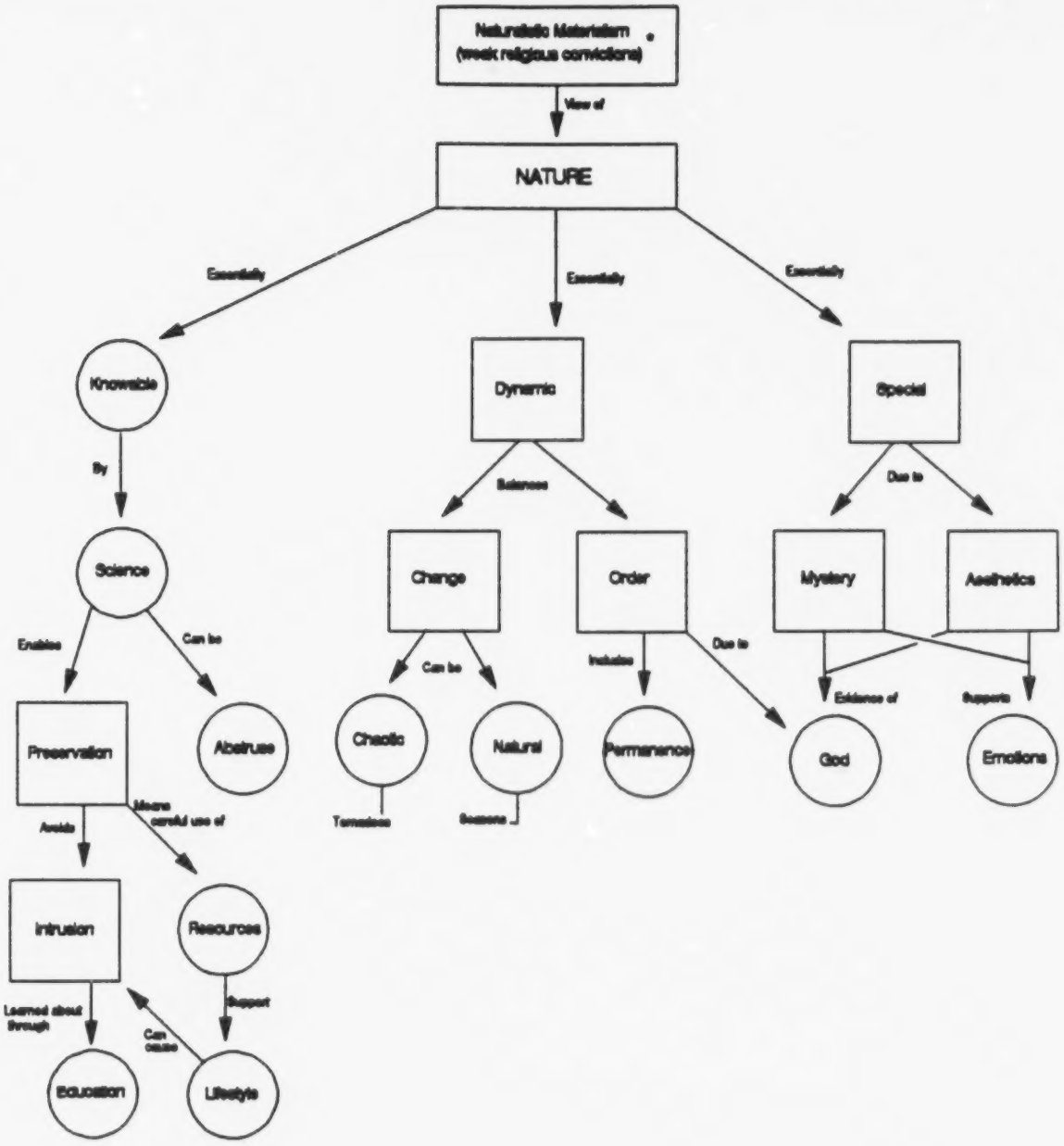
[But], we destroy natural areas due to pollution and toxic waste. We don't even know what we're doing to the environment because we really don't know that much about the environment to begin with. We're just haphazard (789-796). I feel we're a throw away society... There is a problem... an epidemic problem... let's start doing something now before we run into so many problems... But we won't. We'll wait (950-978).

Nature is also a *resource*.

You can't live without nature (450,451). The basics... food, clothing, shelter and without nature we don't have those things (938-941).

D. Nature is *changeable*.

I don't think that nature is all that orderly. We would like to put it in a nice neat little box but you can't... as much as we try (1031-1035). You can't always predict nature (613,614).



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Conceptualization of Nature: CASE 15/#10

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Interview #10: Jackie
Summer 1990

A. Nature is the *natural*, material world around us.

Nature to me is the outdoors... the woods and the trees and brooks and, you know, streams and things (43-46).

B. Nature is *special*. It is fascinating. It has beauty and mystery, and at times makes one think about God. It supports one emotionally.

I'm used to the beauty of the outdoors and it is beautiful and even... the trees and the sky and all the changing seasons... and the snow... the changing of the leaves and things. That's what I mean by beautiful (340-350).

There are a lot of unknown things about nature. I wonder about all of them. I wonder about the little insects in the forest and things like that so it's a mystery to me how it's things all fit together and works together... two different feelings, I guess. One is this mysterious feeling... all these things around me and how it works and all fits together and then the other one is I get this feeling it's like a special place... it's kind of holy (287-325)... nature just gives me a very special feeling, I mean, when I'm like out in the woods... the beauty and the mysteriousness of it all and it's sort of religious to me. I mean, it's like a special place (273-282). I'm not a set person in one religion but nature does make me feel that there is a God when I see how things are created and what is happening (937-945).

Pleasantness is I how feel when I am in nature... seeing it makes me feel real good inside and a calm feeling just... pleasant (368-374).

C. There is *change* in nature:

In some ways nature is changeable (416,417)... changing seasons (382)... there is nothing ordinary about nature. I mean, there is always something happening... Nature is always changing. You know what the weather can be like. You never know when we're going to have an earthquake or a tornado.

There is also *order* in nature:

In some ways nature is changeable but then in others it's not... like it's always there... nature is always out there (416-421). There is an order to some things in nature... you know how the trees turn and that kind of orderly thing... the process of the changing like that. You may not know when it's going to happen, but there is an order to that. I think nature is chaotic when a volcano goes off, for example, but not as a rule.

Nature is orderly because it was made that way:

Everything fits together in nature... there is always something happening... but it all seems to fit together... God created things to work a certain way (1106-1167).

D. It is possible through science to have *limited knowledge* about nature.

Even all the scientists and everything can't predict what's going to be happening next. We know a lot about nature but there's a lot of things that are happening that I don't think people know (575-582).

It is important for scientists to study nature so that we can know what impact we are having on nature.

Nature needs to be studied so we can know what effect we're having on it and what we are doing to it. This means different types of scientists. There's an effect not only in the air and the water and the soil... I'm sure there's an effect on the animals (958-984).

E. Knowledge of nature enables the *management* of nature. However, we must guard against using *resources* for excessive lifestyles.

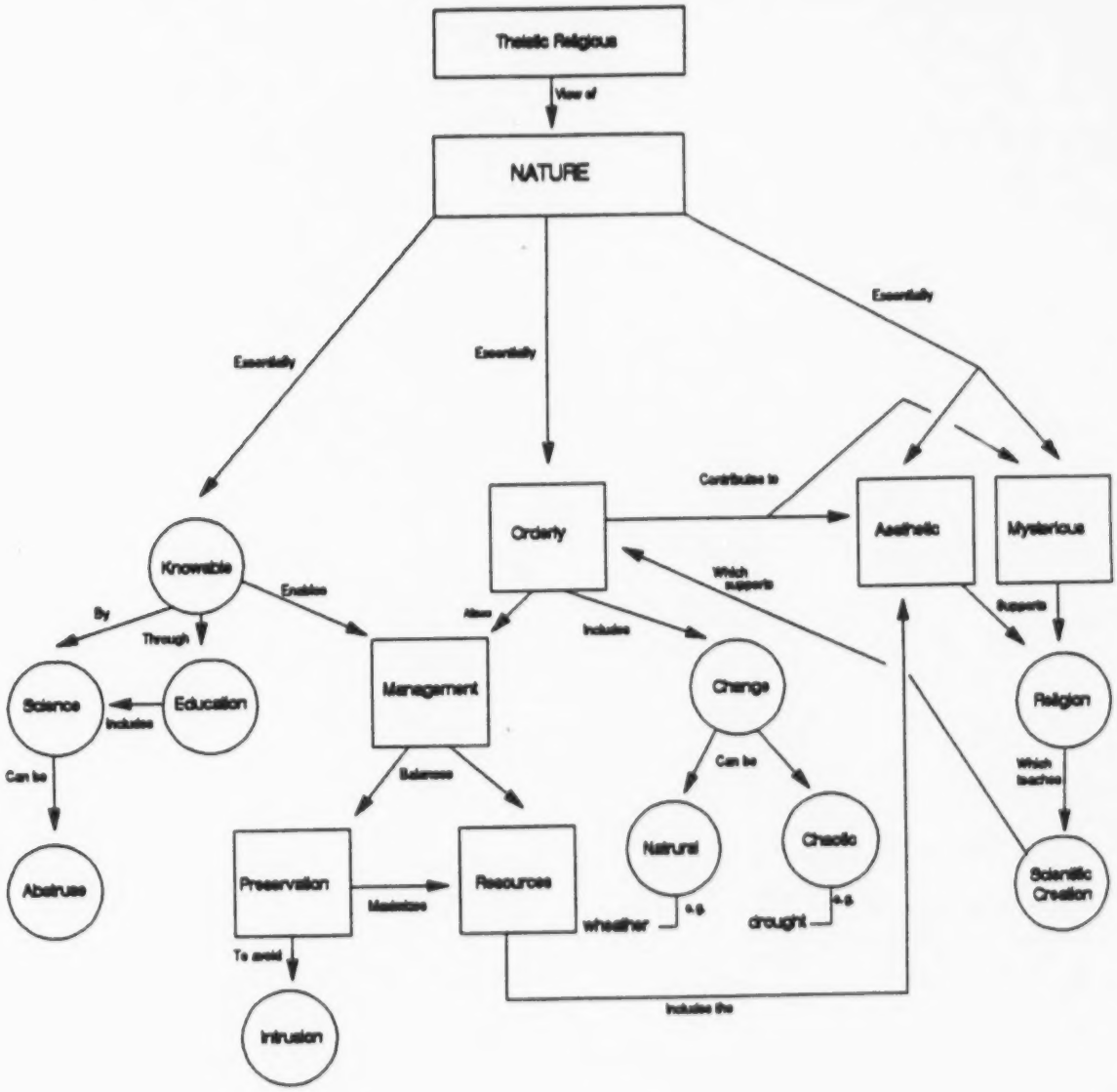
> Our resources come from nature (818,819)... but there are many things that we're obligated to that I really don't think we need to have. I mean, we can live more naturally without all the plastics and the things we're doing and we use more of our natural resources than we need (843-858).

The management of nature involves *preservation*.

> We're polluting all the water and the air... we're polluting our air with our cars and vehicles and industrial plants and I think we need to do something about these things or we're not going to have what we have down the road. We're polluting our ground by burying so much garbage and the plastics and everything (772-783). If man doesn't wake up to what's happening, maybe nature won't be there. I mean, we're... destroying a lot of it (1091-1098).

Education increases our awareness of what is happening in nature.

> I go to school... [and I've learned] the effects that we're having on nature and so I think about it a lot. I learned a lot in school... in chemistry... it's making me more aware (1024-1042).



Conceptualization of Nature: CASE 16/#11

Interview #11: Kelly
Summer 1990

A. The natural world was *created* by God. The natural world reflects God in its order, purpose and beauty.

I believe in the creation theory (343-345)... I think that God created everything... when I think of things he has created I think of beauty and goodness... there's a lot of beauty and goodness in nature (1129-1140).

As you go through the Bible and the things that... Christ did, you know, he had to do everything that he did... he had to do this thing and he had to do this next one and it was like all in order... it needed to be done and it was done... [Likewise], Everything has to be done [in nature], ... the big animals have to eat the little animals... little animals have to eat... the little bugs and they have to do that to survive so it... it has to be done (561-594).

[Nature is] orderly... sometimes it seems kind of a mess... way things happen but... it all happens... for a purpose even if you don't see it right on the surface... the seasons come in order all the time, the food chain... everything has a purpose for happening in nature... orderly (393-410).

B. There is an *aesthetic* quality about nature that supports me emotionally and religiously:

[Nature] is just so pretty... if you really get out... you see all the different colors and the flowers on the cactus and the birds and the [birds] making nests inside the cactus and the mountain tops with a little bit of snow on top and the red rocks up in Sedonna... some things are really breath taking... it's really beautiful (260-295). Nature is just nice to look at... and it's just relaxing... it's just real nice to look at (1160-1164). When I think of what God has created, I think of this beauty and goodness in nature (1129-1140).

C. There is also a *mysteriousness* about nature that supports me emotionally and religiously:

[Nature] is mysterious... I think most spiritual things are kind of mysterious... I mean... just being overcome with a feeling of... like a godliness or something like that and then I think that everything... that you relate to as something holy is something mysterious... like everything in the Bible is kind of mysterious (521-545).

Things just... sometimes they just happen. I mean... everything can be fine and great one moment and then a tornado can hit and just everything can be destroyed and it can be just fine one moment and then the clouds... all come and bring the storms... things happen but you don't know why... I mean... like the seasons all come at a certain time and it seems like bears hibernate in the winter and it's just these things that happen... they're so, like weird sometimes (194-235). I mean, you don't understand why... you look at the stars and you think... how can those stars be just out there hanging? Or you think that there is some life out there... well, if it's possible here then why can't it be possible some place else and that's like mysterious (479-500).

I mean, you know things about [nature] but... I just can't compre-hend... like why does this happen or, you know, why does that happen? I know... how it happens... but why does it happen? You know, I just can't grasp some things (666-683).

D. Nature as stated above has order, but there is also *change*:

[Animals] die naturally or die because there was no water, I mean, that's kind of cruel and mean... to have them starve or thirst, but it's nature... that's just how things go (73-91).

You can sit for an hour... for a long time ... and watch clouds move and change (422-448)... [Nature] is just different from place to place... you can go two miles down the road and... it's never the same (627-643).

There is also chaotic change that comes from dangerous storms and animals, for example.

E. In a very limited way nature is also *knowable* (666-683). Nature is studied by environmentalists and scientists (1087-1109). One can study science but it can be difficult:

> There are parts [of science] that are so difficult... I can grasp, like the food chain... but you talk about the smallest possible organism... and there's something smaller than that! ... and there are so many things that are there that you can't see... and its hard to understand (1360-1376).

F. The reason that knowledge about nature is necessary is that such knowledge is needed for the proper *management* of nature.

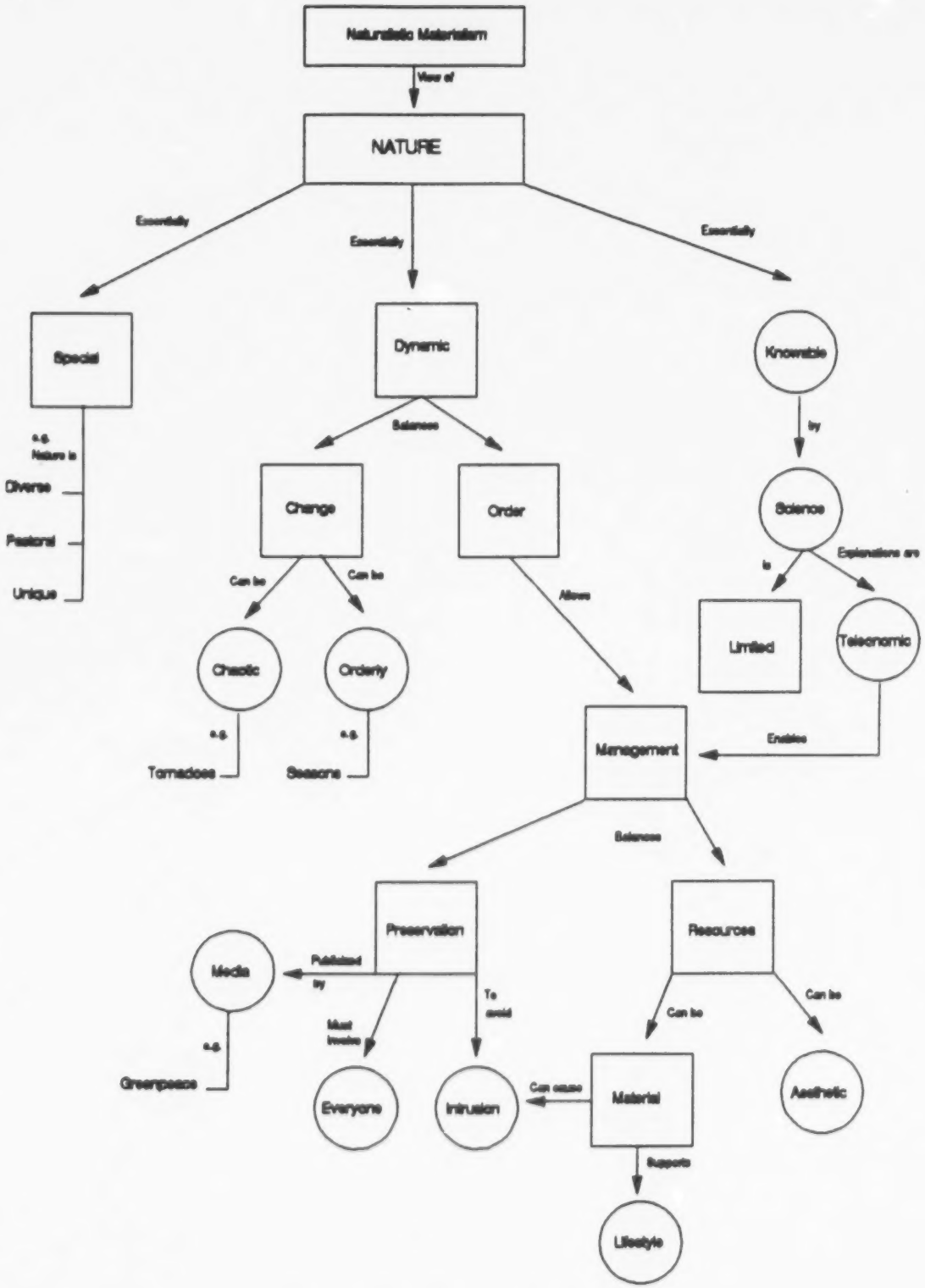
> Nature is something that should be studied so that we can learn more about it. [For example], acid rain... I think we need to study and not only to figure out... is it man destroying nature or is it just nature [producing acid rain]... [also], I think we need to study and not only to figure out... how we can get more resources out of nature, you know, with helping it to not drain it at the same time, you know, but to get more out (1030-1073).

Nature is an essential *resource*:

> We need the stuff... the things that nature provides to survive. We need to have water... have food... we can get shelter... you can, I think, survive in the desert with... it has everything that you need to survive... and without it then we probably wouldn't exist (888-903).

Management also implies *preservation*:

> Some people just take advantage of nature... people who think we have an endless supply of water... who think that there's so much out there... they can dig up these plants and take them home with them because the desert's full of them... they throw beer cans or their trash out the window... pollution needs to be watched because it's already damaged a whole lot of nature (918-943).



Conceptualization of Nature: CASE 17/#12

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Interview #12: Linda
Summer 1990

A. Nature is the *material* result of *natural causes*.

Nature's... everything around us that hasn't been ruined by man yet... (36-40). I'm not super religious and I don't look at a plant or a mountain or whatever and say, "That's God's work." I mean, that's part of the earth and it's there. I'm not religious (694-700).

B. Nature is *special* because of its uniqueness, diversity, and serenity.

[There is] nothing else like it. Nature's nature. It's so diversified that it's special (207-214). It's really serene... a serene quality, not a spiritual [quality, however] (708-711).

C. Nature is a *dynamic system* of both change and order. There is constant *change*:

[Nature is] constantly changing. All the different atmospheres and the earth and stars and everything. Everything is changing (349-353). Even the different seasons... different things happen from one fall to the next (329-331)... animals going through their life cycle and starting over... the food chain... it's all changeable (184-190).

Sometimes change can be chaotic:

It can be dangerous... avalanches, poisonous snakes. Nature... that means tornadoes and all kinds of other things... that kind of thing can kill (221-230).

Nevertheless, there is *order* in nature:

It's orderly... it kind of goes through its cycles and stuff (274-285). It's because of the seasons. It goes through a certain pattern, I guess, but it's still not ... not immaculate... referring to like a room or something, but it's orderly (371-377). Tornadoes and stuff are random? I don't believe they are. I think they hit where they hit because of wind currents and stuff (730-734).

D. An important aspect of nature is that it is an *essential resource*:

[Without resources] we'd live like prairie people if we didn't have all... if they didn't like get things to make plastics and all different kinds of things. In the medical field a lot of that stuff comes from nature and drugs come from nature. We'd more or less be dead if it wasn't for people researching and pulling that stuff out of nature (643-654).

However, in our pursuit of resources we must also *protect* nature:

We need nature for [for resources]... Of course, we shouldn't be tearing it all up... We make things or get food or materials or whatever, like mining... when they do their mining, maybe they could do it in a better way so that it doesn't tear up the mountains and stuff. We need it for resources and then we need it to look nice. Like the rain forests... chopping down the rain forests and ruin the world and it looks ugly, too (511-535).

I am bothered by what is happening but what I can personally do to protect nature is limited:

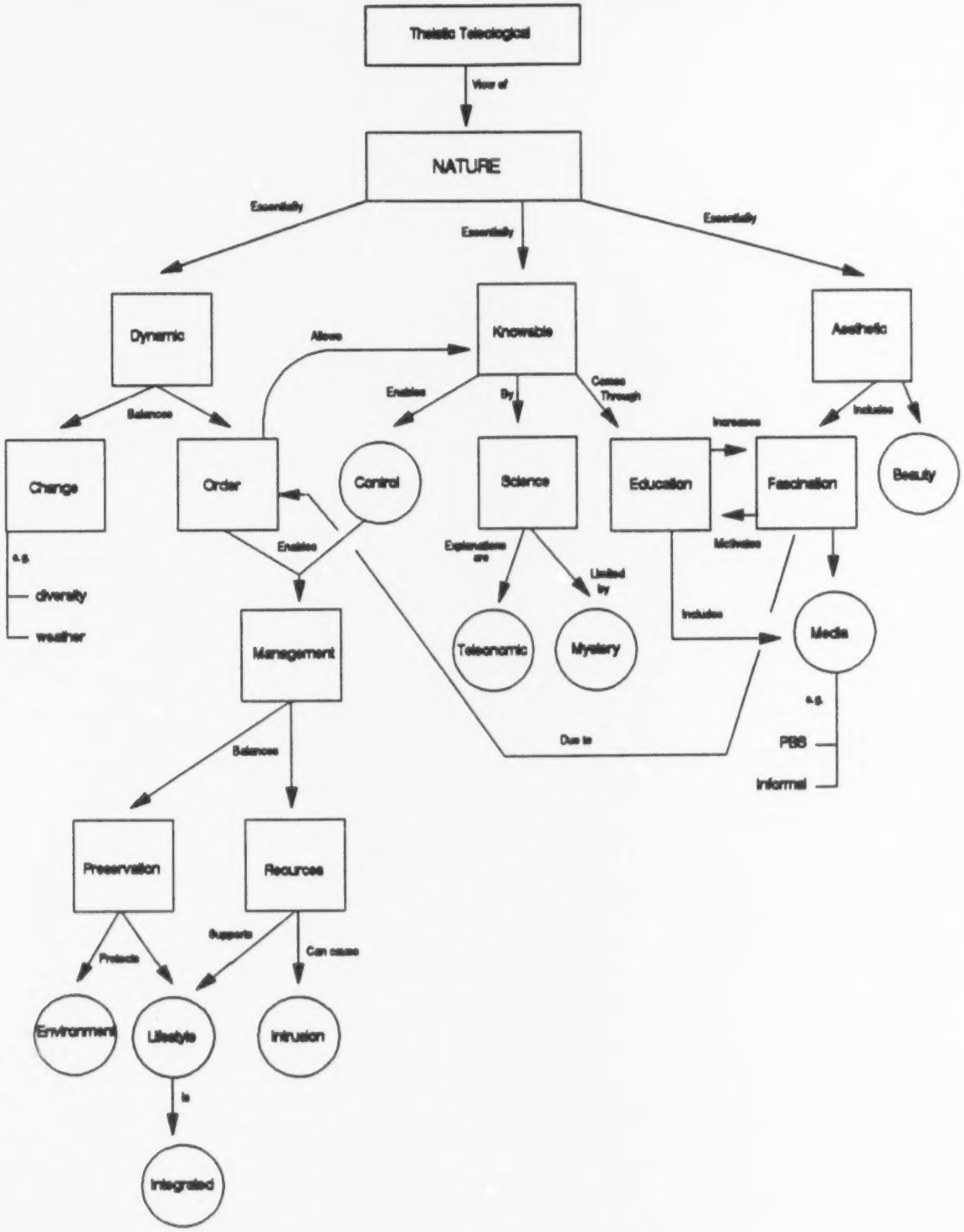
I'm concerned about [nature]... I have a two year old and I wonder what it's going to be like when he's bigger and... it looks like heck. I'm concerned about it. I don't know what I can do besides not littering and things a single person can do. I can't change it all by myself, but... that bothers me that everything is being ruined (560-572).

E. It is possible to have *limited knowledge* about nature:

> There's so much to [nature]. We know a lot about it but we haven't really even scratched the edge. There's stuff out there that we don't even know that's there... as to how things work and stuff... I know people in the science area, there's a lot of stuff they don't know and I know even less (122-157).

Knowledge of nature helps us both to find resources while protecting nature:

> It's important to understand how things work in nature [because] we'd more or less be dead if it wasn't for people researching and pulling that stuff [resources] out of nature (643-654)... [and] to bring up the rain forest again and you can... they should realize that that's there for a reason and they're screwing up the rest of the earth by removing it... things work together like that... that's why we need to understand... Those trees are there for a reason and we need to understand what their function is (585-598).



Conceptualization of Nature: CASE 18/#13

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Interview #13: Mindy
Summer 1990

A. Nature is the creation of God and thus nature has certain characteristics. Nature is *orderly*:

> All divine creation is orderly... (143-150). No matter how much we think some aspect of [nature] is chaotic or unpredictable or has no meaning, the more we learn about it the more we find there is meaning and... reason. It all fits together. It was divinely created (503-511). It's beautiful that it all interconnects and works together and everything depends on everything else... (119-134). Nature... does have organization and interconnections (365-375). [For example], an extra heavy long winter where there's no forage for the deer is a control on the deer population so that they don't become too much to support and different "bad" things turn out to have a good effect in another area. It may not look like it's connected right at the first... It takes awhile to find it but it's usually there (546-559).

But nature is a dynamic system. While there is order there is also change and diversity:

> One thing you can say about nature is that it never stays the same... it's not stagnant... It's alive... evolving system. It's not stagnant or still... (173-199). Even if it is everyday weather... (439-446).

B. Because it was created nature cannot be a result of chance. There is *purpose* in nature:

> But if God... didn't create nature, then it just happened and if it just happened... There doesn't have to be a purpose if something just happened. But most things that we know about don't just happen... there's a reason for them to come about and a reason for the continuation of it. A lack of God would, to me, mean chaos (610-624).

C. Because it was created it is also possible to have *knowledge* of nature:

> There are mysteries but they're not infinite mysteries. Eventually we'll figure it all out. I believe [nature] was created divinely for our use and for us to learn and understand and be able to use the laws... (119-134).

Science provides fascinating knowledge about nature that can be learned through education:

> As I continue my education, the more real [nature] becomes... the less mysterious it becomes... the more I enjoy learning more about it... (242-259). As I'm forced by requirements to learn more in college about like physiology and anatomy... and it becomes more understandable and more real, like the synapsis are real now where they were nothing before... I didn't even know they were there... it makes me want to learn more... (316-327)

D. Nature is a resource that must be *managed* responsibly:

> [Nature is] a resource and it's also what allows our lifestyle to be the way it is... and... we can learn how to control parts of it (740-751). [However], when people choose not to think about it they contribute to the downfall of nature... People that throw dirty diapers on the street or even use them continually in some landfill. That bothers me. They're not thinking about nature. Nature is their life. They may not think about it now but it's not going to be long before it's going to hit them right over the head (774-804).

Knowledge of nature enables wise management:

> Without the knowledge of it that we have not had in the past we've caused a lot of damage and we're paying for it as well as other species and the actual earth is paying for mistakes made in ignorance, so we do need to study it, learn more about it so that we can prevent ourselves from ruining it (644-654).

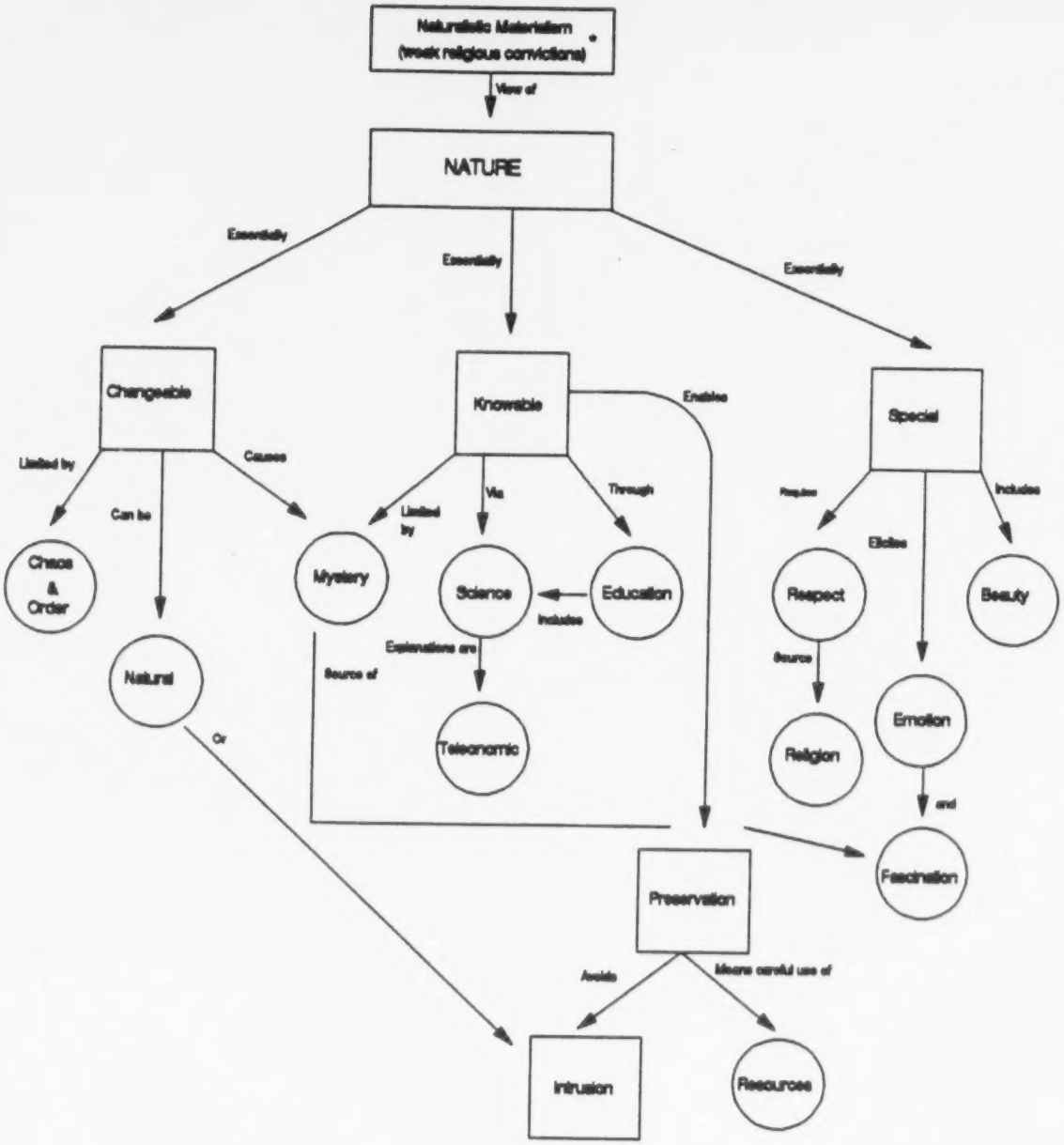
We study nature so that we can live more harmoniously with nature. We are an integrated part of nature:

> [Nature is] the only resource... for everything because nature to me encompasses everything and we wouldn't be here if it wasn't for nature because we're part of nature, so not only wouldn't we enjoy anything... we wouldn't be here to have anything to enjoy (713-726). The ecosystem we live in relates to us and we relate to everything else around

us (25-27). What we breathe, what we eat, what we feel, the way that the barometric pressure affects our emotions, the way we deal with each other and how much we can deal with each other or how little depending on what's going on around us in nature. It affects all our relationships. It affects whether we reproduce or not. Everything. It just completely, totally affects our "normal lives" (216-230).

E. There is also in nature an aesthetic quality that combines elements of fascination and beauty:

All divine creation is... beautiful, even sad or... unappealing parts of it still all have their beauty (143-158). It's orderly... that's why it's so beautiful because it all... it works and fits together (119-134). The less mysterious it becomes... the more I enjoy learning more about it (249-254).



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Conceptualization of Nature: CASE 19/#14

Interview #14: Nora
Summer 1990

A. Nature is the naturalistic, material world around us.

> I guess I would define it as everything that is not touched by man... All outdoors and the creatures and the sky and the earth... (26-35) you can see it and touch it and smell it and, you know that it's really there... it's reality... (324-330). I don't think that there is so much [divine] intervention as people like to think (640-653). Every little thing was placed for some unknown purpose and that it would all take care of itself... we learn in the cycles and things... even through death you provide life... nitrogen, or whatever... is provided for the next bunch of people (1042-1065).

B. Nature is knowable though our knowledge of nature is limited _ there is a mysteriousness to nature. What we know is contributed to by science.

> I don't think you can ever know enough [about nature]... (489-494) but I'm under the impression that it is being studied from all different aspects... biology, microbiology, chemistry, maybe even sociology... (1083-1145). The mystery of it is... the best we can do is to get as close as we can to see how it's supposed to go and then always anticipate changes. I think that it's mysterious in a way that we don't understand a lot of things... I would think that you have to keep in front of your minds that there is much more to this mystery than you even know today (112-173).

C. Our knowledge of nature is relational. We study nature so that we can live harmoniously with nature.

> I'm under the impression that it is being studied from all different aspects... maybe even sociology because whatever is going on out there we have to get along with it... (1083-1145). We don't understand a lot of things and we can mess up things we don't know about at the time (146-173). I think that they're finding out more and more about, you know, the spray cans and what it's doing to the ozone which affects us... (817-857). I think the more educated that you are, the more that you can understand and the lower education that you have you just live from hand to mouth. You're not really worried about nature 'cause you got... your focus is very small... (984-1031).

Rather than intruding upon nature we must learn to preserve nature.

> you take from nature what you need and then you leave her... in the way you found her... I think that it's okay to take the things that we need as long as we don't get slobbish and let them ... you know, glass and junk and pollution and waste and things like that just everywhere (899-947). I know people that if you would just sit down and talk to them about anything to do with nature ... it's like, it's there ... it's always going to be there. I mean, they just don't get it... but when I've learned so much about it... from chemistry and biology and microbiology... classes that I've taken, it's like, wait a minute ... it won't always be there if we don't do something to preserve it... (955-982).

D. In nature there is considerable change. Some change is natural. It limits our knowledge and is a source of mystery. Some change is intrusive like pollution and can be avoided.

> nothing is ever what it seems and that things can be changed and altered by minute changes and alterations all the way up to big changes and alterations and so what you think is orderly or what you think is "normal" may... change tomorrow... Mysterious would be the one word that I think would pretty much encompass that (112-173). Like a species for instance ... if there's too hot a summer or too cold a winter, or whatever... what would be the normal population of a certain species might be killed off because of this... Snow capped mountains and it turns into water and the water comes down and fills up the river. What happens if there's no snow (743-787)?

Natural change in nature is limited. Nature is not without order, but the natural variety and change in nature can appear rather chaotic.

> Things can change things. You can't foresee everything and so chaos is just a matter of things always interacting with other things... (285-304). [On the other hand] everything has its own, you know, quality and place... (512-524). There is order in chaos! (252-258)

E. Nature is special in a sense that is almost religious. Nature deserves respect.

> [Nature] should be treated with reverence... with great respect... (334-347). I... feel an emotion that there's some sanctity there, you know, that's being trespassed against... (359-363) like going to a park and finding papers rolled up and cigarette butts and this and that and the other thing. It's almost blasphemy because, I mean, here's this beautiful park... and let's keep it clean... and pristine (662-672).

Nature evokes emotion. It is beautiful and it is tremendously fascinating.

> I think that nature can be an overwhelming experience... (222-233) [like what] you would find investigating or examining something out in nature and it would be awesome... (799-805). I think there are so many things that you don't understand but the course of events is so astonishing and so stunning and exquisite that you have to say it's beautiful even a lion chasing down a gazelle and everything is really in essence there's a beauty to it because they know what they need and they go and they do it and, you know, so you have to say that it's beautiful. I mean, even if it's not pleasant it can still be beautiful (188-204). I really like science courses and I do well in them, but it's almost like a sponge, I mean, it's like "tell me more, tell me more, this is great and this is wonderful." You know... it seems that I didn't even have any idea that existed... things that... existed that I didn't know much about them and I think it's an attitude... [of] reverence and awesome (1378-1398).

Interview #15: Oprah
Summer 1990

A. Nature is the natural, material world around us.

> [It is] not synthesized [but is] original (105-118). [Regarding] nature, I think of [it] as natural, [an] organic substance (665-669).

B. Nature is a dynamic system that involves both order and change. Some change is natural.

> animals can adapt to their environment... they constantly change their physical attributes to the changing environment... the environments change (144-159).

Change can also result from the intrusive behavior of man.

> the ozone layer seems like [is] in constant change... (217-222) we're facing... global warming (466-472).

However, there is also an order in nature.

> Things seem to be grouped in orderly fashion... the evolution of man... (93-98) evolution [is] an orderly sequence... (168-175) the planets and the stars... their arrangement, they form an orderly pattern (277-287).

C. Order in nature makes it possible to have at least limited knowledge about nature.

> orderly means that things are grouped in a specific way... they're called phylum in [my A&P] class... (244-251) I think it is possible to know things about nature... not possible to know everything about nature... not everything is determined... not everything is completely understood... (344-367).

In a sense there is a mysteriousness, possibly religious related, that limits our understanding of nature.

> I think in general [nature is] mysterious because... it goes almost to your religious beliefs... how everything started and evolution and although it's an orderly sequence, there's still a lot.. unanswered especially when you start talking about constellations and stars... (168-179).

Knowledge of nature is relational. It tells us about ourselves.

> I think that [nature is] representative of the way we are. If we can understand the things in nature we can understand things about ourselves possibly (515-525).

Knowledge about nature can be gained through science, though sometimes complex. For example, one might ask why an earthquake occurred.

> The earthquake in San Francisco I don't think was the result of purpose [unless] there was a purpose... maybe when people talk about the plates moving apart and how all the continents were once joined and maybe this [earthquake] is a continuation of that kind of thing (693-723).

D. Nature is an important resource and knowledge of nature allows us to manage our interaction with nature properly.

> If you are going to use the resources you should be responsible to learn more about the situation and come up with ways... preventative measures to correct some of the problems before they get worse (598-606). I am concerned about pollution and the damage it does to nature... pollution in the waters and also in the air... global warming... (442-472).

Thus it is important to have knowledge about nature. People can gain this knowledge about nature though education.

> I think [learning about nature] should be introduced more to elementary students so that they can have some common knowledge. I grew up in Chicago and I've never been, you know, a nature nut ... myself, but I think just the

exposure to nature and the in-depth understanding of why these things are so important ... why the water pollution and the air pollution and all those things are so important. I think it should be a universal thing that everyone should want to learn (533-569).

E. Nature is special and it is fascinating.

Like the ordinary things in nature are pretty special and how complex some of the things are that we don't realize how special they are (128-133). It seems that nature has a lot of tranquility and it's really soothing and, I don't know, an emotional outlet ... all that stress really can be relieved getting back to nature and doing natural things seems really tranquil. I don't think of it as religious (189-203). It's really mind probing [boggling] information. very deep... introspective thoughts come to mind... especially with constellations and the planets and... how everything evolved (313-328).